Part 4

Complex Issues

Circular References and Other Complexities in Financial Structuring, Cash Flow Waterfalls, Reserve Accounts and Debt Repayments

Chapter 36: Resolving Circular References in Acquisition Models if you are Worried About Computing Interest Expense on the Average Balance of Debt

Circular References in Corporate and Acquisition Models

One issue that not too many people in the world care about is coming up with an elegant way to compute the interest expense on the average of opening and closing debt balance rather than simply the opening balance in financial models without using the iteration button in excel and without using a macro. This is an important issue to some people who want their models to be very precise. In a model with items computed on an annual basis, cash flow after interest expense affects debt balance, but the debt balance affects interest expense which in turn affects cash flow. While the problem of more accurately measuring interest expense may be trivial to most people and is certainly not a key driver of virtually any analysis (it is fine to use the opening balance in general), solving the problem illustrates elegant ways in which functions can be used to solve problems in financial models. For many advanced modelling issues, creating your own user defined functions opens a whole new world of solving problems that otherwise use things like tedious copy and paste macros.

Some of the techniques that can be used to solve circular references such as the problem of interest expense on the average debt balance are listed below. The table lists five different techniques along with comments regarding the problems with the method. Because there are big problems with the macro iteration button method and the copy and paste macro method, this chapter describes how to create a flexible and transparent function using one of the last two methods -- the algebraic approach or the isolated function.

Method	Problems with Method
Use the "Enable Iterative Calculation" button in Excel (the iteration button)	This method can destroy models and is dangerous to use. The models become unstable, goal seek does not work and errors cannot be undone. The method should virtually never be used.
Input fixed values in cells that cause the circular problem and use a goal seek to find the fixed value by setting the difference to zero	This method can avoid the dangers of the iteration button but it means that whenever you must change something in a model, you must run a goal seek. Another problem with this method is that it does not solve multiple circular reference problems.
Find the value of fixed values in a similar manner to goal seek method, but use the solver to find multiple values at the same time.	Using the solver resolves problems of the goal seek whereby multiple circular references can be established. But it leaves the problem that you must re-run the solver any time you change something. Another big problem is the solver can be very slow and clumsy for anything but very small models. It is also limiting because all calculations must be in one sheet.

Use a copy and paste macro to find fixed values with an iteration routine.	This is the most common method used these days for fancy models. You compute the item causing the circular reference and they copy and paste special to a fixed cell. The method solves the problem with goal seek where multiple circular references cannot be solved and it is better than the solver method which can be very slow and limits the calculations to one sheet. But this method leaves the models just as clumsy as the above method and it means the copy and paste macro must be used whenever you want to do any sensitivity analysis or optimisation.
Resolve circular references using an algebraic equation	This is an old fashion method that is the most elegant way to solve circular references. It requires no iteration on an indirect or a direct basis and all optimisation and scenario analysis can be directly applied. The problem with this method is that coming up with an algebraic solution can be tedious and sometimes almost impossible.
Resolving circular references using an isolated function that contains an iteration loop	This method in which calculations that cause the circular reference are repeated in a function resolves problems with the clumsiness and the un-transparency caused by standard copy and paste macros. All data tables, optimisation and scenario analysis can be automated and any circular reference can be resolved. The only problem with this method is that it involves a bit of old fashion programming.

Step One in Resolving Circular References: Understanding Why Circular References Arise and Whether they can be Solved

In describing how to solve the problem of circular references and other challenging problems in modelling, it is useful to begin with a simple problem and gradually add complexities until you get completely stuck. The organisation of this chapter follows such an approach in describing how to resolve the circular reference problem in models other than project finance models. An acquisition model with a cash flow waterfall without taxes and a cash flow sweep is the starting point for the analysis. This case is relatively simple because all of the cash flow is used to pay down debt rather than either building up cash balances or reducing debt in revolving credit agreements. In this case with a cash sweep, there is also no effect of the interest expense on taxes and on dividend payouts. Taxes (particularly with net operating losses), differences between interest income and interest expense rates and dividends (especially with limits when earnings are negative) complicate the problem.

Corporate models and acquisition annual models are often developed on an annual basis. In these models an implicit assumption is that the cash flows occur on a continual basis throughout the year. When computing various revenue, expense and capital expenditure items it is reasonable to approximate the continuing cash flow with an assumption that cash flow occurs in the middle of the period. Given this notion, it does not make sense to assume that incremental interest expense or incremental interest income can be computed on the basis of the opening debt or cash balance. When the opening balance is used for interest expense on new debt or interest income on new surplus cash generated, no cash flow is being used to pay down debt and there is no cash build up that increases interest income until the end of the year. This means there is an implicit assumption that all revenues received and all expenses and capital expenditures occur right at the end of the year. If the opening balance of debt is used in calculations meaning that the balance of debt does not change until the end of the period, then the interest expense is not precise. The true interest expense would be less than interest computed on the opening debt balance if cash flow is positive and used to repay debt over time.

Making an assumption that the revenues occur in the middle of the period is much more reasonable but it creates the circular reference problem. The circular reference occurs because the closing balance of the

debt or cash affects the interest expense. But the interest expense is a determinant of cash flow that drives the closing balance. The circular reference is illustrated by the little diagram below:

Closing Balance → Interest Expense
Interest Expense → Net Cash Flow
Net Cash Flow → Closing Balance

Some people suggest that from a philosophical standpoint that circularity should not occur in financial models because circularity does not occur in real situations. If circularity existed in financing a transaction, the process would work something like the following. The sponsor would go to the bank and ask for a loan commitment. Then, the bank uses the amount of the loan commitment to compute fees. After that, the sponsor asks for a larger loan to cover the fees that were not known before he asked the bank for the loan. With the larger loan, more fees are charged and the sponsor needs an even higher loan. Then the loan is higher and process keeps going on and on and on. The circular reference resembles the film "Groundhog Day" where life cannot move forward and the same problems occur again and again and again. Instead of the above scenario with the banker and the sponsor going around, it is more realistic if the sponsor asks for a loan commitment that will already include the fees, the debt service reserve account, and the interest during construction that can cause a circular reference problem. When a company goes to a bank to ask for a loan in a project financing transaction, the company has already created a model and evaluated the sizing of debt, presumably through modelling the debt service coverage or some other criteria. This is the philosophy that circular references should not be in a model.

Notwithstanding philosophical considerations about whether circular references occur in the real world, various combinations of the funding approaches cannot be solved without running into a circular reference problem where the debt or equity commitment drives the total funding needs and when the funding needs drive the financing commitment. From a modelling standpoint, the fees and the loan commitment depend on the financial model, but the model must be computed with some kind of fee and debt commitment assumption. When an item in the model depends on using the model itself, a circular reference sometimes cannot be avoided.

Circular References from a Cash Flow Sweep using the Iteration Button, Goal Seek, Solver and Copy and Paste Macros

To illustrate the problem of circular references in corporate finance and acquisition models, you can create a simple example with a cash flow sweep where interest expense is computed on the basis of the average debt balance rather than the opening debt balance. In the cash sweep example, the cash flow available for re-paying debt is the minimum of the cash after interest or the opening balance:

Debt repayment = MIN(cash flow after interest, opening debt balance)

You can create a debt schedule below the cash flow analysis with an opening balance, a repayment from the formula above, a closing balance and an interest expense calculation. Because the interest expense is computed on the basis of the average balance, a component of interest depends on debt repayment which is in turn dependent on the cash flow after interest as illustrated by splitting the interest expense formula:

Interest Expense = Beginning Balance/2 x Rate + Ending Balance/2 x Rate

Since the ending balance is the beginning balance less the cash sweep, the interest expense is a function of debt repayment:

Interest Expense = Beginning Ending Balance/2 x Rate + (Beginning Balance - Sweep)/2 x Rate

If you make this little model, then after you calculate the interest expense a dreaded blue arrow will appear indicating you have a circular reference. Excel has an option to resolve this kind of circular reference through making iterative calculations using a special button that you access from the FILE

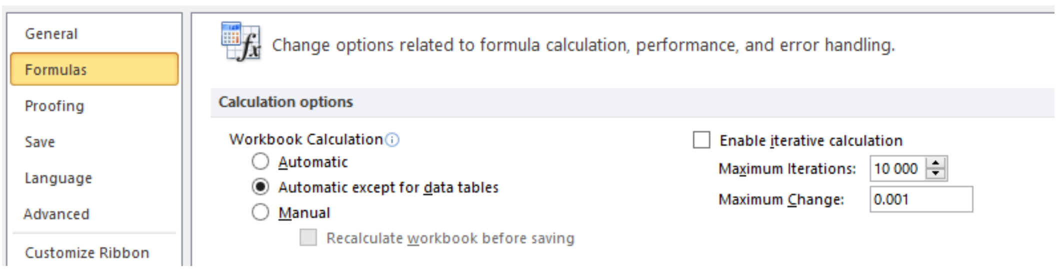
menu. This button seems to make the whole circular reference issue go away. The iteration button can be accessed by going to the File tab, clicking on Formulas and then selecting the Enable iterative calculation check box as illustrated below. This solution seems to be a nice feature that eliminates the problem. But it can be a very dangerous thing to do. Some of the negative consequences of using the iteration button include:

(1) the model can become unstable meaning that when you make an error that results in a bunch of #VALUE's, you cannot use the undo key. This can be a real pain;

(2) the goal seek tool and some other tools do not work;

(3) if the model is large, it can become very slow as the whole model will be computed over and over again; and,

(4) sometimes the model does not even work;



The next few paragraphs discuss alternative ways to resolve the circular references without using the iteration button. While these methods correct the stability problems, the alternative solutions can create new problems and be even worse than the using the iteration button.

One solution to the circular reference problem involves re-computing the interest expense somewhere outside of the cash flow process. After you make this calculation, you can enter a fixed value for the interest expense in the body of the model. The difference between the computed value and the fixed value should be zero. To compute the fixed value you can use the GOALSEEK tool or the SOLVER tool as follows:

Step 1: Enter a fixed value for the interest expense computed in the cash flow statement

Step 2: Compute the difference between the fixed interest expense and the computed interest expense below the calculation of interest expense on the average balance in the debt schedule

Step 3: Use the GOALSEEK tool to set the difference to zero by finding the fixed interest expense amount.

Step 4: Repeat the process for each year of the model

Instead of repeating the goal seek in step 4, you could use the SOLVER tool. In this case, do not put anything in the top part of the SOLVER screen, set the changing cells to the series of fixed interest expenses and add a constraint that the difference must be zero. Either the GOALSEEK or the SOLVER method are have many problems as follows:

(1) If you have another circular reference somewhere else, the process can be difficult (it may be impossible with the GOALSEEK).

(2) If you want to use the GOALSEEK tool to do things like find debt capacity or break-even points, the process can become very cumbersome with the SOLVER.

(3) You cannot use the DATA TABLE and other tools scenario and sensitivity tools.

An approach that is analogous to the GOALSEEK method is to create a copy and paste macro. Some people consider themselves sophisticated if they can apply this method and make a macro. In general this approach can be constructed using the following steps:

Step 1: Make sure there is a fixed value and a computed value for the thing that is causing the circularity as described above (e.g. the average interest expense calculated in the debt schedule).

Step 2: Compute the year by year difference between the two calculations and then sum all of the differences in a separate cell.

Step 3: Begin recording a macro. Then copy and paste special as values from the computed interest expense to the fixed interest expense. Create range names for the computed interest expense, the fixed interest expense and the sum of the difference in interest expense cells.

Step 4: Modify the macro by including range names and including a while loop. The while loop repeats the copy and paste command until the sum of the differences converges to zero. You can be fancier with the copy and paste macro, but this is the essence of the process. Making a macro that includes a while loop is illustrated below.

```
Sub CopyPaste()
'
' CopyPaste Macro
'
While Range("difference") <> 0
'
    Range("computed").Select
    Selection.Copy
    Range("fixed").Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
        :=False, Transpose:=False

Wend

Application.CutCopyMode = False

End Sub
```

Fancier ways to add bells and whistles to copy and paste macros (adding iteration limits, displaying the iterations and simplifying the code) are described below in the context of project finance analysis.

The copy and paste method has many serious advantages even if you attach the macro to a fancy button and call it an optimisation routine. With a copy and paste macro, the model cannot be used together with the goal seek or solver tools; data tables cannot be created for sensitivity analysis; the iteration can occasionally result in an infinite loop; and doing any sort of analysis with the model can become a cumbersome ugly process.

Solving Basic Circular References in with Cash Sweeps in Acquisition Models using Algebra

A more elegant solution to the problem of circular references then using macros or allowing the iteration button to be active is to create a function that derives the interest expense from an algebraic expression. The algebraic solution is complicated by taxes, dividends and variations in interest rates between income

[and expense. To begin the discussion, consider an acquisition model where all excess cash flow is used to pay down debt before any dividends are allowed (a cash flow sweep). Further assume no taxes. In this case, the repayment of debt can be computed in the cash flow statement using the MIN function consistent with the discussion of cash flow waterfalls above.

When working through the circular reference functions through creating an algebraic process, it is generally best to solve for the repayment and write down a bunch of equations that include a term for debt repayment. You can then substitute variables, re-arrange things and ultimately replace the cash flow after interest with an equation that does not depend on repayment. This equation for cash flow that does not depend on debt repayment can used in the cash flow section of the model. In the simple example of a cash flow sweep with no taxes, the arguments for the function are the operating cash flow (EBITDA less working capital changes and capital expenditures.)

To solve the circular problem, begin by writing down a couple of equations that define interest expense and the repayment of debt assuming that the interest is derived from the average balance rather than the opening balance:

Interest Expense = Opening Balance x Interest Rate – Repayment x Interest Rate /2

Repayment = MIN(Cash flow, Opening Balance)

Cash Flow = Operating Cash Flow – Interest Expense

Using these equations, you can create and expression for the repayment by substituting and re-arranging variables. In general the algebraic method involves fining an equation for repayment and replace the cash flow equation with a repayment equation as illustrated below:

Repayment = Operating Cash Flow – (Opening Balance x Interest Rate – Repayment x Interest Rate/2)

Repayment + Repayment x Interest Rate/2 = Operating Cash Flow – Opening Balance x Interest Rate

Repayment x (1 + Interest Rate/2) = Operating Cash Flow – Opening Balance x Interest Rate

Repayment = (Operating Cash Flow – Opening Balance x Interest Rate) / (1 + Interest Rate/2)

Once you have found an equation it is sometimes fairly long and painful to put into excel. As an alternative, you can put the equation into a function. Then you can combine your function (which could be named SWEEP) with the MIN function as illustrated below:

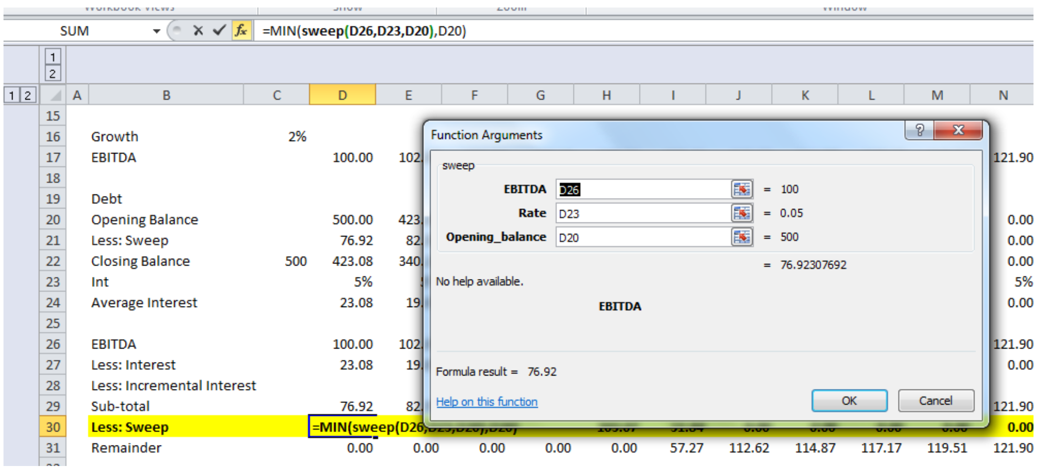
Repayment = MIN(SWEEP(operating cash flow, interest rate), Opening Balance of Debt)

Contents of the function and implementation of the function in the model are illustrated in the diagrams below. Using this function avoids all of the problems associated with the iteration button, the goal seek and the copy and paste method. The model is stable and does not have to make iterations; you can run goal seeks, solvers and data tables; the model does not slow down and the model is transparent.

```
Function sweep(EBITDA, rate, Opening_balance)

        sweep = (EBITDA - Opening_balance * rate) / (1 - rate / 2)

End Function
```

Growth	2%											
EBITDA		100.00	102.00	104.04	106.12	108.24	110.41	112.62	114.87	117.17	119.51	121.90
Debt												
Opening Balance		500.00	423.08	340.16	250.89	154.92	51.84	0.00	0.00	0.00	0.00	0.00
Less: Sweep		76.92	82.92	89.26	95.98	103.07	51.84	0.00	0.00	0.00	0.00	0.00
Closing Balance	500	423.08	340.16	250.89	154.92	51.84	0.00	0.00	0.00	0.00	0.00	0.00
Int		5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Average Interest		23.08	19.08	14.78	10.15	5.17	1.30	0.00	0.00	0.00	0.00	0.00
EBITDA		100.00	102.00	104.04	106.12	108.24	110.41	112.62	114.87	117.17	119.51	121.90
Less: Interest		23.08	19.08	14.78	10.15	5.17	1.30	0.00	0.00	0.00	0.00	0.00
Less: Incremental Interest												
Sub-total		76.92	82.92	89.26	95.98	103.07	109.11	112.62	114.87	117.17	119.51	121.90
Less: Sweep		**=MIN(sweep(D26,D23,D20),D20)**				**103.07**	**51.84**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Remainder		0.00	0.00	0.00	0.00	0.00	57.27	112.62	114.87	117.17	119.51	121.90

In entering the function, you can use the f_x box to guide the inputs to put into the formula as illustrated below:



The problem with the algebraic method is that equations become more tedious with more complex problems. But the principle of substituting variables and re-arranging equations is the same. The bad news about more tedious formulas is that they are painful and sometimes boring to work through. The good news is that if you create a function and use variable names that are easy to interpret, you only have to do it one time. Once you have made the function, you can copy the function to other functions or even create an add-in to excel. The formulas are generally easy to transfer because by the time you get down to an income statement and a cash flow statement in a financial model, the format should be almost identical.

Solving Circular References with Functions that Repeat the Equations that Cause the Problem

The final method for solving the circular reference problem extends the function method introduced above and applies some of the iteration ideas from the prior methods. The final approach solves problems in a similar manner as the algebraic method, but you do not have to work through subtitling the equations. Creating a function with an iteration process allows you to use the GOAL SEEK, DATA TABLES and keeps the model stable. This method often has advantages relative to algebraic method because finding a single equation is very difficult if not impossible in many circular reference problems such as the case with taxes and a net operating loss.

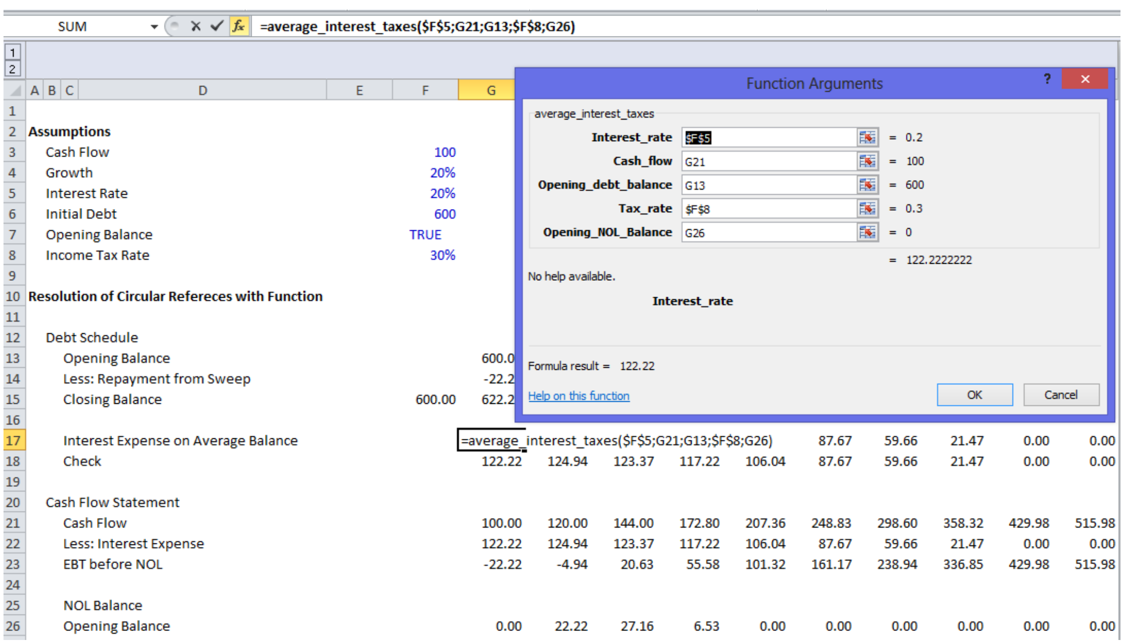
To apply the method of creating a function the first step is to decide which equation should be fixed with the function so as to remove the circular reference. Next you can write down equations for the items that are related to the equation that is causing the circular reference. Once the equations are established, all of the inputs to the equations must be included as inputs to the function (you cannot use cell references when writing equations in a function. Finally, an iteration process should be added to the function where the equations are repeated until some kind of convergence is established. For the case of the cash flow sweep, the function could be defined for the interest expense. The interest expense depends on the average debt and the cash flow. But the cash flow depends on the interest expense. The iteration can compare the interest expense from the prior iteration with the currently computed interest expense. The function below illustrates the process. The last step in the function is testing whether the sweep computed from the prior iteration is the same as the sweep computed from the same iteration. If the last iteration and the current iteration are the same, the iteration process can be stopped and the function can be stopped.

```
'
Function average_interest(interest_rate, cash_flow, opening_debt_balance)

For Iteration = 1 To 30
    last_sweep = sweep

    average_interest = ((opening_debt_balance + closing_debt_balance) / 2) * interest_rate

    sweep = WorksheetFunction.Min(cash_flow - average_interest, opening_debt_balance)

    closing_debt_balance = opening_debt_balance - sweep

Next Iteration

converge = Abs(sweep - last_sweep)

If converge < 0.000001 Then Exit Function


End Function
```

This function works in the same way as the algebraic technique above in that the file does not lose any functionality associated with file stability, sensitivity analysis or optimisation. Further, the function is fairly easy to change with more complex equations. When taxes are included in the analysis, computing the equation using the algebraic method becomes more complex. The problem with including taxes in a financial model with circularity is that interest expense affects taxes that in turn affects the cash flow available to repay debt. Because the taxes are part of the interest calculation, an equation for taxes must be included in the function as shown below. This example of adding taxes demonstrates that the equations in the function must correspond to the equations in the model. If equations for a net operating loss carry forward were also included in the cash flow analysis, using the algebraic equation would not be possible because of the conditional nature of the operating loss and because of the accumulation of the carryover. However, if the function is used the net operating loss can be incorporated. To include the loss carry forward, the function must read in the opening carry forward balance as well as the tax rate. Then the carry forward can be included in the function using the same equations that are in the excel model as illustrated below.

```
Function average_interest_taxes(interest_rate, cash_flow, opening_debt_balance, tax_rate, opening_NOL_Balance)

For Iteration = 1 To 30
    last_sweep = sweep

    average_interest_taxes = ((opening_debt_balance + closing_debt_balance) / 2) * interest_rate

    taxable_income = cash_flow - average_interest_taxes
    NOL_created = WorksheetFunction.Max(0, 0 - taxable_income)
    NOL_used = WorksheetFunction.Min(opening_NOL_Balance, WorksheetFunction.Max(0, taxable_income))
    closing_NOL_Balance = opening_NOL_Balance + NOL_created - NOL_used
    adjusted_taxable_income = taxable_income + NOL_created - NOL_used
    taxes_paid = adjusted_taxable_income * tax_rate

    sweep = WorksheetFunction.Min(cash_flow - average_interest_taxes - taxes_paid, opening_debt_balance)

    closing_debt_balance = opening_debt_balance - sweep

Next Iteration

converge = Abs(sweep - last_sweep)

If converge < 0.000001 Then Exit Function

End Function
```

Operating the function involves using the f_x thing in the excel formula box as illustrated below:



Chapter 36: Creating a Structured Cash Flow Process in a Corporate Model and Resolving Circular References Associated with Average Short-term Debt and Cash Balances

Creating a Structured Model for the Cash Flow Process in a Corporate Models

If you thought the process of incorporating the net operating loss into an acquisition model with a cash flow sweep was not bad enough, the formulas are even more tedious and there are more iterative adjustments when solving the problem for a corporate model. Added complexities in the corporate model

arise from differences between the interest income rate and the interest expense rate and because dividends may be incorporated in the model. Dividends will probably have some sort of relation with income which in turn is driven by interest income and interest expense. The good news is that it is possible to solve the problem and as stated above, after you have done it one time, you can use the function over and over again in other models.

Before beginning the discussion of the formulas and iterative procedures in functions it is good to discuss the financing structure of a corporate model. Because of the different interest rates and presentation of interest income and interest expense the surplus cash and short-term debt should not be lumped together but instead maintained in separate accounts in the debt schedule section. Further, the account for required operating cash should be segregated as should other existing debt and exiting instruments that create income such as notes receivable. When the surplus cash and the short-term debt are added as separate accounts with opening and closing balances, the end of the cash flow statement resembles a cash flow waterfall. If the cash flow is positive, then short-term debt is first paid off followed by increasing the surplus cash. If the cash flow is negative, then surplus cash is used first followed by issuing more debt. As with the cash flow waterfall process described above, the MAX function is used to test whether an item is positive or negative and the MIN function is used to cap or limit an item. The cash flow process at the bottom of a corporate model cash flow statement can be represented by the following step by step process:

Step 1: Compute the cash flow after dividends in the model. The remaining cash flow after dividends drives the operating cash balance, the changes in the surplus cash and the changes in the short-term debt balance.

Step 2: Subtract the required cash for operations from an analysis of the level of revenues relative to the amount of cash required. This does not cause any circular reference.

Step 3: Compute the remaining cash flow after operating cash flow. The cash flow subtotal is the line in the model that can be used to isolate the circular reference. If this line is computed from a function, then the circular reference can be broken. This line is divided into the remaining rows through using MIN and MAX functions.

Step 4: If the cash flow subtotal is negative, remove money from the surplus cash account. Use the MAX(-cash flow, 0) function to test whether the function is negative and then compare the amount of the cash flow removed with the opening balance of the account using the MIN function:

Reduction in Surplus Cash = MIN(MAX(-cash flow,0),opening surplus cash)

Step 5: If the cash flow is positive, then put remove money from the debt balance account as long as the opening balance has a positive balance. As described in the cash flow waterfall chapter, the MAX and MIN functions are the key to modelling a cash flow waterfall. This time the functions are:

Reduction in Short-term Debt = MIN(MAX(cash flow,0), opening debt balance)

Step 6: Compute another sub-total after reducing surplus cash and reducing short-term debt so that you can determine how much to add to the surplus cash account if the remaining cash is positive and how much you need to add to the debt account when the remaining cash is negative.

Step 7: Use the MAX functions for the final two lines that measure the increase in cash and the increase in surplus cash. This time test for a negative cash flow to determine how much debt to add and test for positive cash flow to test for how much cash to add:

Increase in Cash = MAX(cash flow subtotal,0)

Increase in Debt = MAX(-cash flow subtotal,0)

The format of such a cash flow waterfall at the end of the corporate model is illustrated below.

Cash Flow Statement

EBITDA		36.00	43.20	51.84	62.21	74.65	89.58	107.50	128.99	154.79
Less: WC Changes		-	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Less: Capital Expenditures		-	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Less: Taxes Paid		-	-	-	-	-	-	-	-	-
Cash Flow from Operations		36.00	-6.80	1.84	12.21	24.65	39.58	57.50	78.99	104.79
Less: Interest Expense on New Debt		9.25	8.50	8.50	8.40	7.87	6.65	4.56	1.64	-
Less: Other Interest Expense		-	-	-	-	-	-	-	-	-
Add: Interest Income on Operating Cash		0.21	0.24	0.29	0.34	0.41	0.49	0.59	0.71	0.85
Add: Interest Income on Surplus Cash		3.75	3.58	3.34	3.27	3.27	3.27	3.27	3.39	4.79
Less: Dividends	0%	-	-	-	-	-	-	-	-	-
Cash Flow after Dividends		30.71	-11.49	-3.04	7.42	20.46	36.69	56.80	81.46	110.44
Less: Required Cash for Operations		0.80	2.16	2.59	3.11	3.73	4.48	5.37	6.45	7.74
Remaining Cash Flow		29.91	-13.65	-5.63	4.31	16.72	32.21	51.42	75.01	102.70
Add: Withdrawl from Surplus Cash when Negative		-	13.65	5.63	-	-	-	-	-	-
Less: Reduction from Short-term Debt when Positive		29.91	-	-	4.31	16.72	32.21	51.42	65.42	-
Remaining Cash Flow		-	-	-	-	-	-	-	9.58	102.70
Add: Issuance of New Debt when Negative		-	-	-	-	-	-	-	-	-
Less: Addition to Cash Balance when Positive		-	-	-	-	-	-	-	9.58	102.70
Remainder		-	-	-	-	-	-	-	-	-

Resolving Circular References in a Corporate Model Using the Iterative Function Approach

When resolving circular references in the context of a corporate model, you can use any of the five methods discussed above. If you use the iteration button, the model is unstable; if you use the goal seek or the copy and paste method the model becomes un-transparent, clumsy and un-usable for sensitivity and optimisation analysis; if you try the algebraic method, the equations become long and messy. This section describes how to resolve circular references using the iterative function.

The trick in taking circular references out the cash flow process in a corporate model is to first compute the remaining cash flow line with a function. This is like cutting all of the blue arrows which appear in excel after you enter a circular reference. The problem with breaking this circular reference with a function is that the interest rate on surplus cash differs from the interest rate on new short-term debt and these amounts depend on how the remaining positive or negative cash is distributed. The equations for interest income, interest expense, dividends and taxes must all be part of a function.

Step 1: Create a function for the cash flow after dividends which is where the circular references are coming from.

Step 2: In the function, write down equations for anything that is causing the circular reference including interest expense, interest income, taxes and dividends.

Step 3: Read in variables that are necessary for computing the equations including the interest income rate, the interest expense rate, the tax rate, the dividend payout ratio and the operating cash flow before dividends, taxes and financing.

Step 4: In the function, you must include conditional statements that reflect the cash flow process as described above. If the cash flow is negative, compute the reduction in surplus cash and use the MIN and MAX functions in the evaluate how much of the negative cash flow is applied to surplus cash. The MIN function can be used to test how much surplus cash can be applied by comparing the opening cash balance to the amount of required cash.

Step 5: If the cash flow is positive, compute the reduction in new debt and use the MIN and MAX function to evaluate how much of the positive cash flow is applied to debt reduction. This again involves using the MIN function and computing the weighting for surplus cash and short-term debt.

The function that can resolve circular references in a corporate model is illustrated below. In creating the function you can open the VBA window and simply write down each formula in the excel model. You have to isolate the area that is causing the circular reference and then make sure inputs such as EBITDA and interest rates that are independent of the circularity. Further, when there are excel formulas using functions like the MIN and MAX functions, you can use the WORKSHEETFUNCTION feature of VBA. Because the iteration repeats the formulas over and over again, the order that you write the formulas does not matter. One strategy is to simply begin writing the formulas in the same order that they appear in the associated spreadsheet.

```
Function cash_flow(EBIT, cash_from_operations, interest_expense_rate, interest_income_rate, _
                   opening_debt, opening_cash, payout_ratio, min_cash)

For Iteration = 1 To 30

    last_cash_flow = cash_flow

    reduced_debt = WorksheetFunction.Min(WorksheetFunction.Max(cash_flow, 0), opening_debt)
    cash_after_reductions = cash_flow + reduced_cash - reduced_debt
    add_debt = WorksheetFunction.Max(0 - cash_after_reductions, 0)

    closing_debt = opening_debt + add_debt - reduced_debt
    closing_cash = opening_cash + add_cash - reduced_cash + min_cash

    interest_expense = (opening_debt + closing_debt) / 2 * interest_expense_rate

    earnings = EBIT - interest_expense + interest_income
    dividends = WorksheetFunction.Max(earnings * payout_ratio, 0)

    interest_income = ((opening_cash + closing_cash) / 2) * interest_income_rate
    reduced_cash = WorksheetFunction.Min(WorksheetFunction.Max(0 - cash_flow, 0), opening_cash)
    add_cash = WorksheetFunction.Max(cash_after_reductions, 0)

    cash_flow = cash_from_operations - interest_expense + interest_income - dividends - min_cash

Next Iteration

converge = Abs(last_cash_flow - cash_flow)

 If converge < 0.000001 Then Exit Function

End Function
```

Chapter 37: Overview of Dreadful Project Finance Modelling Issues and Understanding the Difference in Problems for Contract and Debt Structuring as Opposed to Risk Analysis Objectives in a Model

Some elements of a project finance analysis are among the most difficult problems in financial models and cause continuing headaches for modellers. The worst nightmares often result from circular logic, resolution of which can and make a model far less flexible for risk and structuring analysis (violating the F in FAST). Project finance models are often very elegant, detailed and sophisticated in terms of representing a project and they include many complex VBA programs to resolve circular references (for example a pressing a picture of a beautiful sculpture for operating a macro that sculpts debt). But if one cannot easily use these sophisticated models to quickly evaluate the effects of different debt structures such as debt sizing from the DSCR or varying the debt tenor and draw down provisions, then the model in fact is all but useless. Similarly, if a model contains hundreds of lines of detail about operating expenses, but it cannot be used to easily measure how a few of the key variables affect returns and ability to repay debt, then how can you call it a good model.

The remaining chapters explain how circular references and other related headaches related to sculpting debt, funding construction and reserve accounts can be minimized. The chapters describe various alternative techniques that should leave your models much more flexible and transparent. Issues addressed include:

- Capitalized Interest, Fees and Unavoidable Circularity
- Debt Repayments and Sculpting
- Debt Service Reserve Accounts
- Maintenance Reserve Accounts
- Cash Sweeps and Dividend Lock-up Covenants
- Debt Re-financing and Valuation of Project in Different Stages

Before discussing details of alternative methods in dealing with circularity and other issues that arise from sculpting, reserve accounts and funding cascades, a summary of items that cannot be resolved without circular references is presented. Issues that genuinely cause circular references should be studied to avoid jumping to create VBA programs as soon as a circular reference occurs when it is unnecessary.

Circular references which can limit the flexibility and transparency of a model seem unavoidable in a project finance model arise from debt sculpting, interest capitalization and funding priorities which makes both the structuring analysis far more cumbersome. This part of the text deals with how to address items that create inherent circularity. Advanced modellers will probably not believe this, but all circularity references can be resolved without copy and paste macros that arguably ruin a model. With a copy and paste macro, the model cannot be used effectively for deriving bids; goal seeks cannot be used; data tables cannot be created; models can blow up; and structuring analysis can become a cumbersome ugly process. To solve the circular reference problem without copy and paste macros or other equally bad techniques, functions can be created that isolate the circular reference and allow all of the flexible analysis that would be present had the SUM function been used to resolve the problem.

The general philosophy in addressing these difficult issues applies the following approach:

1. Understand the source of the circular logic and whether some sort of resolution process is necessary (many of the DSRA problems can be resolved without a circular reference).

2. Program the model in the excel sheet and attempt to isolate the circular reference problem into a single cell.

3. Understand the portions of the model that are causing the circular reference problem and re-write formulas from the excel sheet into a function.

4. Create an iteration process around the formulas in the function and use values from the function rather than the fixed cell that would otherwise be part of a copy and paste macro.

The Complexity of Problems Depend on Whether you are Using your Model for Coming up with Contract and Debt Structures or Whether you are Using your Model for Evaluating the Risk of a Transaction

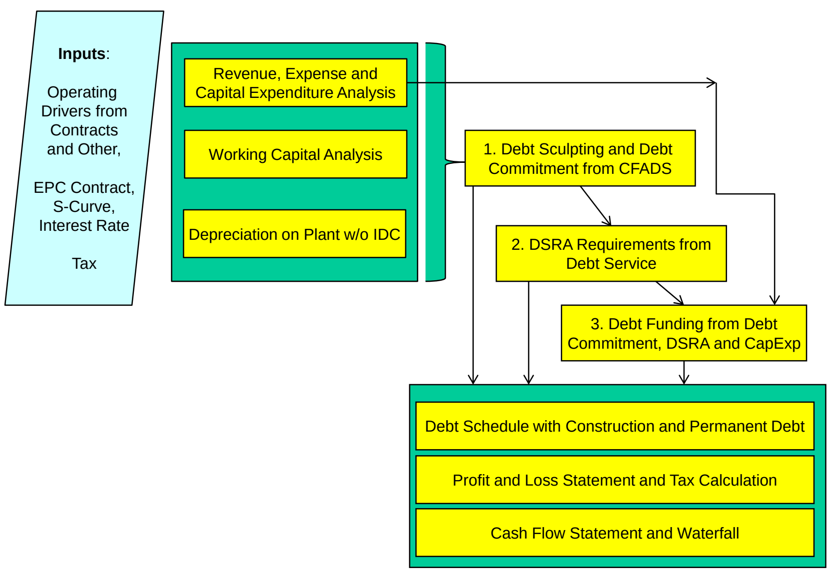
In addressing the issues of debt sculpting, debt funding, debt service reserve accounts (DSRA) and maintenance reserve accounts (MRA), the notion of having different procedures in the model that distinguish between structuring the model on the one hand and performing risk analysis on the other hand must be understood. Most of the difficult project finance problems discussed below address structuring rather than risk analysis elements of a model where debt commitment, debt funding and DSRA accounts are derived from operating cash flow or cash flow available for debt service (CFADS) or from alternative defined debt gearing parameters.

Structuring in a model refers to the process of coming up with the debt and equity commitments and repayments using a particular scenario. Issues in structuring include determining the amount of debt from

a target debt service coverage ratio; computing the required price in a long-term contract such as a PPA from required return and debt parameters; developing the repayment terms of debt from the debt tenor and the debt service coverage; testing different possible structures for a debt service coverage ratio covenant; including different levels of credit enhancements such as debt service reserve accounts (DSRA), cash sweeps and maintenance reserve accounts; and, evaluating different funding possibilities such as pro-rata, debt first or an equity bridge loan. When considering multiple structuring options, it can be difficult to efficiently evaluate different debt structuring options if macros are used to resolve circular references. If a macro button must be pressed every time the debt service coverage ratio is changed, the process can be cumbersome as you have to wait for the macro to clunk along its various iterations before determining how a certain structuring element affects returns. Worse, if the model is used to compute the required contract prices that can achieve IRR targets and DSCR objectives, changing the contract payment requires running a macro, the process can become almost impossible. This is because the macro button must be pressed each time one of the operating parameters change. Given the difficulties in efficiently performing debt structuring where macros are used to resolve circular references, the general approach of the discussion is to develop algebraic functions or isolated iteration functions that avoid the copy and paste process.

In contrast to transaction structuring, risk analysis in a model addresses how the transaction works if certain operating assumptions are varied after the financial structure has been established. In this analysis, the amount of debt, the repayment of debt and deposits and scheduled removals from the debt service reserve account are established and fixed. Unless prospective covenants are modelled, there should be no circular reference in the model. This includes potential circularity associated with the use of prospective debt service in a debt service reserve account when cash flow sweeps are present. Tricky issues in modelling risk analysis involve the cash flow waterfall discussed above and the alternative methods of risk analysis addressed in the next chapter. Aspects of the waterfall that address structuring mechanics that apply in downside or stress scenarios such as cash flow sweeps, covenants, re-financing, back-up credit facilities and use of debt service reserves should not be part of the initial structuring process.

The diagram below illustrates a project finance structure with sculpting followed by calculation of the DSRA followed by calculation of debt funding.



Items that Cause Circularity and Give You a Headache

In resolving the problem of circular references, you need to first understand why the circular logic exists like a doctor must first diagnose a problem before coming up with alternative possible cures. Three of the principal items that cause circular references in a project finance model include:

- **Debt Funding, Interest During Construction and Fees:** The amount of debt that is available to fund construction may be driven a given percentage of the total cost or driven by cash flow and CFADS. If debt is given by a debt to total capital percent, a problem arises because the total project cost (total capital) includes capitalised fees and interest. Because debt funding effects interest but interest effects total cost a difficult circularity problem arises. (The debt funding is the amount of debt that is actually used to pay for cash expenditures rather than being capitalised for interest and fees.) To compute the interest and the fees, the amount of debt borrowed that is the basis of these calculations is a required input. But this amount of debt funding is not known until the interest and fees are computed because the total debt commitment including interest and fees. Resolving the circular reference can be accomplished by fixing the amount of total fees and interest with a copy and paste macro. It is difficult but not impossible to come up with an algebraic method for resolving the process. Using an iterative method in a function requires a relatively simple for and next loop.

- **Sculpting, Taxes, and Interest during Construction:** When computing debt repayments using the debt sculpting technique, repayments are directly tied to cash flow after tax. Because the debt repayments affect interest expense and cash flow is defined to be after tax, a circular reference arises. Cash flow and tax effects interest, but interest effects taxes. The circular reference problem is compounded because of the tax effects of depreciation on interest during construction and amortization of fees. Although this circular reference is very difficult to avoid without a macro you can make a function that encompasses both the funding and the repayment phases of a project. One can get close through using a VBA function combined with a backward induction but not get all the way there.

-
- **Interest Income, DSRA and Taxes:** Debt service reserve accounts which impose a cash buffer on a project seem to create an impossible circular reference. In many models there is some kind of elaborate copy and paste macro associated with modelling the account. When using a debt service coverage ratio to size debt, the repayments affect the DSRA and the interest on the DSRA affects the amount of sculpting. Despite the seemingly intractable problems created by the DSRA, these problems can be solved through careful structuring and through development of functions, thereby avoiding the need for VBA programs. However, in cases where the debt size is driven by a given ratio, the total project cost driven in part in by the DSRA but the DSRA depends on the level of debt resulting in a funding circular problem.

The order of remaining chapters for more complex structuring issues in project finance models corresponds to the tree elements above and includes discussion of maintenance reserves as well as refinancing and valuation:

- The first challenging item is computing the total debt commitment and the debt service reserve to establish debt funding. Since part of the debt commitment is taken up by interest and fees during construction, not all of the debt commitment can be used to fund construction. To solve this problem, some kind of process for separately computing the adders to project cost related to the size of the debt must be developed.

- The second problem is related to sizing debt and computing the amount of debt commitment from the operating cash flows. Resolution of the sizing of debt depends on the repayment method applied. If sculpting is applied, the circularity associated with taxes must be resolved. If level payments or annuity payments are assumed, a flexible goal seek process can be incorporated in a function.

- The third problem relates to debt service reserve accounts. Once the total debt commitment and the debt repayments are established, the debt service reserve account can be computed. If the debt commitment is derived from cash flow, then the debt service reserve is independent of the funding process and only depends on prospective debt service which in turn depends on operating cash flow. The first period debt service requirement is necessary to compute how much debt funding is possible in different periods.

Chapter 38: Understanding Funding Techniques in Project Finance and Developing User Defined Functions to Efficiently Solve the Horrible Circular Funding Problem

Funding of Construction and Circular References Caused by Capitalised Interest, Up-Front Fees and Commitment Fees

The manner in which a project is funded with senior debt, subordinated debt and equity during the construction period can have important effects on the earned rate of return to equity holders. In some projects with parent guarantees, the equity may not be contributed until the construction on the projects are completed (this type of loan is could be an equity bridge facility). In more traditionally financed projects without parent guarantees, the lenders may insist that equity is contributed before debt to demonstrate that the equity holders have “skin in the game” and to assure that they cannot abandon the project before investing any money. In yet other cases, the equity and debt are contributed on a proportional or pro-rata basis relative to their commitment based on construction milestones. When financing a project, the interest accrued on a loan is sometimes paid to lenders, which increases funding needs. In other cases the interest is not paid to the lender, but instead is capitalized or rolled-up to increase the size of the loan. As with interest costs, the fees paid to lenders can also either be currently paid or be capitalized. If projects are financed with bonds instead of bank loans, the funding occurs in discrete periods and the amount of money contributed to the project from bondholders is more than is necessary for funding the project in a single year. In this case the amount of funding exceeds the sources of funds and interest income earned on cash balances funds some of the construction expenditures. In resolving circular references

Depending on which set of funding techniques described above are applied, the funding schedule can be relatively simple or it can be one of the most difficult problems in the programming of a model. Various different possible combinations of funding structures are discussed in this chapter which include capitalizing or paying interest; bond financing with fully drawn funding in a single period; funding on a pro-rata basis where equity and debt are funded in a proportion of their commitment or funding debt or equity before debt; and, capitalization or current payment of fees. When some of the financing combinations are used (in particular when capitalised interest and fees are not applied and equity is derived after debt is sized) then circular reference can sometimes be avoided through use of algebra or through carefully structuring a model. In other circumstances the solution is to write a function that solves the funding problem in a variety of different structuring possibilities.

The most obvious problem in funding occurs from interest and fees when the total gearing ratio is given. Assume that the total project cost without interest and fees is 1,000,000 and the gearing ratio is 50%. The amount actually borrowed – the funding amount -- will be more than 500,000 because some of the total debt funding is associated with interest and fees on the loan. If the construction period covers more than one period, then there is no simple formula to find the amount of debt issued associated with the cost including interest and fees. Instead, the calculation requires some kind of goal seek function, copy and paste macro or function that must be applied to derive the amount of cash funding available from issuing the debt together with capitalised interest will result in the total funding. In developing a model that has an inherent circularity problem such as this case, it is useful to understand the source of circularity and develop methods to solve the circularity that are as simple as possible. To demonstrate the problem, the discussion below begins with cases where no circularity exists. Next, various structural

features that cause circularity are added one item at a time to illustrate why the circularity arises and how to resolve the circularity problem. A fundamental idea in working through these issues is that when creating a model with circular references it is good to find and fully understand the ultimate source of the circular reference and solve the problem at the source rather than treating a symptom of the problems after you see a lot of blue arrows in excel. Through finding the ultimate source of circularity, redundant circular references are not treated and potential alternative methods can be applied. If unnecessary circular references are solved through using some kind of macro, goal seek or solver, the process becomes even less transparent and the model is even less flexible.

Case 1: No Circular Reference -- Pro-Rata Funding, Interest Paid During Construction and Debt Size from Cash Flow

Circular references arise from the manner in which debt and equity fund construction and the way in which interest and fees during construction are paid or capitalised. The first case is an illustration of a situation where circular references do not exist. Assume the amount of debt funding is determined in advance from the CFADS and debt draws are made depending on the amount of money that is spent on construction (for example, if one fifth of the total expenditures are made in the first period, one fifth of the debt is drawn). The draw-down percentages are determined from a schedule where the construction expenditure for the current period is divided by the total construction across all of the whole construction period implying that the draw down percent does not depend on financing. Importantly, the amount of equity funds is computed on a residual basis from the total amount of funding needs less the debt and the case assumes that there is no interest capitalized, but that interest during the construction period is paid as it is incurred. If a sculpting method is used that does not require a goal seek function, the structuring part of the model can be made without any circular reference. The reason there is no circular reference is that the total debt and equity commitment can be determined from the construction expenditures without making any adjustments for interest expense and fees that are paid on the debt. As debt and equity financing commitment is independent of the interest and fee calculations, the process is not circular. Since equity is used as the balancing item in computing the funding requirements (i.e. the senior debt and the sub debt are input), then there is no circular reference.

The step by step approach for computing funding in the case of pro-rata draws and debt given by cash flows is shown below:

Step 1: Compute cash funding requirements for each period from construction and interest

Step 2: Compute draw percents independent of debt commitment = ($\text{Construction}_t / \Sigma$ Construction)

Step 3: Debt Funding = Fixed debt commitment x draw percent (i.e. independent of funding)

Step 4: Equity Funding = Funding Requirements – Debt Funding

Calculation of the total uses of funds that is the starting point for all of the methods below is illustrated below. Note that the interest during construction and the fees are included as part of funding requirements whether the interest is paid or capitalised. Adjustments for capitalised interest are shown on the sources of funds implying that with capitalised interest, amounts are shown as both a source and a use of funds:

Assumptions	
Construction Period	3
EPC Cost	100,000
Debt Commitment	80,000
Interest Rate	10%
Debt Funded	80,000
Equity Commitment	20,000
Interest Paid	TRUE

Period	-2	-1	0
Uses of Funds			
Construction	33,333.33	33,333.33	33,333.33
Add: Interest Paid	-	2,666.67	5,333.33
Total	33,333.33	36,000.00	38,666.67
Sources of Funds			
Debt	26,666.67	26,666.67	26,666.67
Equity	6,666.67	9,333.33	12,000.00
Total	33,333.33	36,000.00	38,666.67
Debt Schedule			
Opening Balance	-	26,666.67	53,333.33
Add: Debt Draws	26,666.67	26,666.67	26,666.67
Add: Interest Capitalised	-	-	-
Closing Balance	26,666.67	53,333.33	80,000.00
Interest Rate	10%	10%	10%
Interest Recorded	-	2,666.67	5,333.33
Interest Paid	-	2,666.67	5,333.33
Interest Capitalised	-	-	-

Case 2: Circular Reference from Pro-Rata Funding with Capitalised Interest or Debt Ratio Input

If the total debt commitment is defined by a given debt to capital ratio or if debt is determined by a given debt service coverage ratio and interest is capitalised instead of being paid currently, the big headaches begin. When interest is capitalised, the total amount of debt that can be used to pay for or fund the cash expenditures of project is not known until the interest cost is computed. But the interest during construction is a function of amount of debt issued to fund the project rather than the total debt commitment derived from the sculpting process. This causes a circular reference that is illustrated below where the periodic debt draws to fund cash construction drive the capitalised interest, but capitalised interest drives the accumulated cash debt funding that determines how much of the total debt commitment can fund construction.

Periodic Cash Debt Funding	→	Capitalised Interest
Capitalised Interest	→	Total Cash Funding of Debt
Total Cash Funding of Debt	→	Periodic Cash Debt Funding

A similar problem is caused when the debt commitment is given from an input debt to capital ratio. This causes a circular reference because debt is driven by total cost plus interest and fees (adders). But the adders are driven by the amount of debt.

Total Debt Commitment	→	Cost plus Adders x Debt Ratio
Cost plus Debt Related Adders	→	Debt Issued per Period
Debt Issued per Period	→	Total Debt Commitment

The circular reference from funding is illustrated by the simple example below. The blue arrows illustrate how the interest during construction drives the total project cost, but the total cost drives the debt and the interest. If you can make the interest during construction or the total debt commitment a fixed cell, you can remove the arrows.

Assumptions				
Construction Period	4			
EPC Cost	100,000			
Debt Commitment	78,212			
Target Debt (use with a goal seek)	72,000			
Equity Commitment	33,520			
Interest Paid Switch	TRUE			
Debt Ratio	70.00%			
Debt Funded				
Funding Percent - Pro Rata	0.25	0.25	0.25	0.25
Debt Funding	19,553.07	19,553.07	19,553.07	19,553.07
Int Rate	10%	10%	10%	10%
S&U Summary				
EPC Cost	100,000.00			
Interest During Construction	11,731.84			
Total	111,731.84			
Debt Funded	78,212.29			
Capitalised Interest	-			
Total Debt	78,212.29	70.00%		
Equity	33,519.55	30.00%		
Total Capital	111,731.84			

Period	-3	-2	-1	0
Uses of Funds				
Construction	25,000.00	25,000.00	25,000.00	25,000.00
Add: Interest Paid	-	1,955.31	3,910.61	5,865.92
Total	25,000.00	26,955.31	28,910.61	30,865.92
Sources of Funds				
Debt	19,553.07	19,553.07	19,553.07	19,553.07
Equity	5,446.93	7,402.23	9,357.54	11,312.85
Total	25,000.00	26,955.31	28,910.61	30,865.92
Debt Schedule				
Opening Balance	-	19,553.07	39,106.15	58,659.22
Add: Debt Draws	19,553.07	19,553.07	19,553.07	19,553.07
Add: Interest Capitalised	-	-	-	-
Closing Balance	19,553.07	39,106.15	58,659.22	78,212.29
Interest Rate	10%	10%	10%	10%
Interest Recorded	-	1,955.31	3,910.61	5,865.92
Interest Paid	-	1,955.31	3,910.61	5,865.92
Interest Capitalised	-	-	-	-
Checks				
Target Debt Ratio	70.00%		Target Debt	72,000.00
Computed Ratio	70.00%		Computed	78,212.29
Difference	0.00%		Difference	-6,212.29

As discussed in the first chapter of this part of the book, there are five general approaches that can be used to resolve this type of circular reference problem:

- The first approach is to use the iteration option in excel which sounds very simple but can lead to big problems when you are trying to use the model.

- The second option is to fix a cell with the accumulated adders (interest, fees and DSRA) and use a goal seek to set the difference between the fixed level and the computed level to zero. This option is problematic because multiple goal seeks must be used and once one goal seek is used it cannot be used again.

- The third option is to create a macro that copies and pastes formulas into fixed cells with a simple iteration loop or to create a macro around the goal seek function. These macros can limit both the flexibility and transparency of a model.

- The fourth option is to develop an algebraic solution which takes a lot of work and may require you to make a function in excel.

- The fifth option is to create a structured function with an iteration loop.

The first three options are tantamount to giving up while the fourth option can be a big challenge requiring a lot of creativity and perseverance. The fifth option can be used to solve any circular reference. You just have to know how to spell.

As stated in the chapter discussing cash flow sweeps, excel has an option to resolve circular references through making iterative calculations which may seem to make the whole circular reference issue not very important. This involves pressing the iteration button in the excel options. However in a large project finance model, leaving a circular reference in a file using the excel iteration option is very dangerous. The models are large and become very unstable and almost impossible to work with in terms of risk analysis and financial structuring. On the other hand, resolving the circular references with macros can make the models far less transparent and flexible as each time an input is changed it is necessary to run a macro and one cannot directly see how calculations are made.

The second and third option can be accomplished with a copy and paste macro or the GOAL SEEK tool. In the case of funding, resolution of a circular reference through copying and pasting involves the following steps:

1. Create an area of the model where the circular reference will be resolved. In this section first link the variable that is causing the circular reference and must be fixed. In the case at hand this variable could be the total debt adders comprising interest during construction, fees related to debt and the debt service reserve account.

2. Next, create a cell a fixed cell for the total debt adders just below the computed debt adders. Link the fixed debt adders to the computation of total project cost shown in the excerpt above.

3. Compute the difference between the computed debt adders and the fixed debt adders. The macro will work by copying and pasting the computed numbers in step 1 to the fixed cell in step 2 over and over again until the difference goes to zero.

4. To create the macro, switch on the macro and then copy the computed cell or cells in step 1 to the fixed cells in step 2. After you have created the macro, you should modify it in order to copy it over and over until the difference goes to zero.

5. To modify the macro to loop around until the difference goes to zero, you can add two lines to the macro. The first line begins the loop called a while loop. The second line ends the while loop. These statements should be above and below the code created by the copy and paste process. The WHILE function can be written something like WHILE RANGE("Difference") <> 0 meaning that the process will continue as long as the range is not difference. The WEND statement simply tells what commands should be copied and pasted.

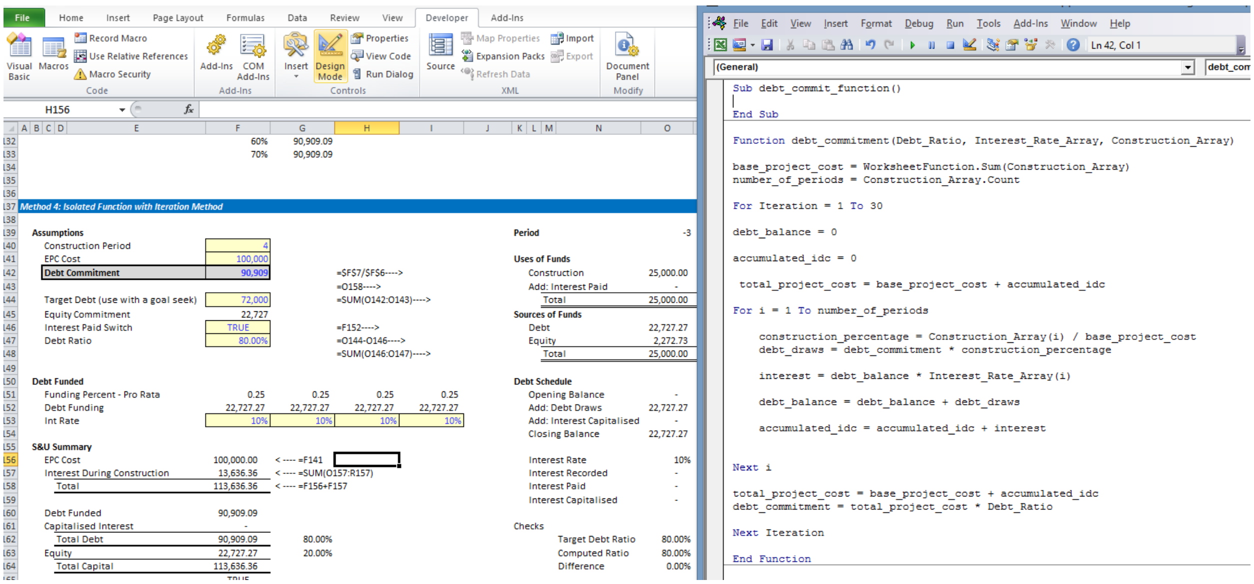
6. As with any macro you should name the ranges so the macro will be flexible when you insert or delete rows or columns.

A copy and paste macro with some extra bells and whistles is demonstrated below. A variable named ITERATION is created that keeps track of how many times the copy and paste macro is looping around. It is good practice to create and IF statement in the macro to limit the number of iterations so that the loop does not continue indefinitely. The macro demonstrated below uses the APPLICATION.STATSBAR function to document how many times the computed cells are copied to the fixed cell. In setting-up the copy and paste macro, if there is only one variable such as the debt adders that is fixed, then all of the copy and paste coding created when you copy the macro can be replaced with a simple statement such as RANGE("fixed_amount") = RANGE("computed_amount"). As stated above, all of the variables such as the fixed funding and the computed funding should be in the same area of the spreadsheet so the process is as transparent as possible.

```
Sub copy_and_paste()

Iteration = 1

 While Round(Range("difference"), 4) <> 0
    Iteration = Iteration + 1

    If Iteration > 100 Then Exit Sub

    Range("fixed_amount") = Range("computed_amount")

    Application.StatusBar = "Iteration " & Iteration
 Wend

Run "re_set_status_bar"

End Sub
```

```
Sub re_set_status_bar()

Application.StatusBar = "SHIFT, CNTL, M ---> show comments     SHIFT,CNTL, Q ----> Hide comments

End Sub
```

If you want to make a use defined function, you can make one that computes the total debt commitment or the debt adders. The excerpt below shows a function for computing the debt commitment. This function is somewhat more complex than the circular functions in previous chapters because you have to compute the interest over the whole construction period before you can re-compute the total debt commitment. Since the debt amount depends on the total project cost, the total project cost must be computed outside of the construction loop. The iteration loop is then a second loop outside of the construction loop. Computing a function to resolve this circular reference is shown in the excerpt below. The excerpt shows the excel sheet as well as the function to demonstrate that when you write the function you are just repeating the same equations in your excel file.



Case 3: Pro-Rata Funding, Capitalised Fees

If the total debt commitment is given in advance as in the example above and up-front and commitment fees are capitalised or paid, a similar problem arises as with capitalised interest. Part of the debt commitment is taken up with fees making less funding available to finance cash construction. As the total commitment is assumed to be given by debt sizing analysis, the total amount of debt that can be used to fund the cash expenditures of project – the debt commitment minus the fees or the debt funding -- is not known until the fees are computed.

To begin the process, assume a simple one period model which is then extended as the case above.

Total Debt Commitment = Debt Funding + Capitalised Fees

Up Front Fees = Total Debt Commitment x Fee Percent

Total Debt Commitment = Debt Funding + Total Debt Commitment x Fee Percent

Once these simple equations are understood, the function above can be modified to include the equations. That's all. After you understand the general approach of making a function you can include more and more stuff.

In addition to up-front fees, commitment fees are charged for debt that is committed but not used (from the perspective of the bank, the commitment represents a risky asset and must be compensated for with

some kind of credit spread.) As with the up-front fee, a problem arises because the fees change the debt commitment relative to the amount of money that must be borrowed. In this case the total amount of debt that can be used to fund the cash expenditures of project – the debt funding -- is not known until the fees are computed. But the fees are a function of the total amount of the debt commitment which is not known until the debt funding is computed which depends on the fees themselves. As with the prior example for capitalised interest, a circular diagram can be drawn for capitalised fees.

Total Debt Commitment	→	Capitalised Fees
Capitalised Fees	→	Debt Funding
Debt Funding	→	Total Debt Commitment

To solve the problem of commitment fees, the un-borrowed debt can be added to the function and the commitment fees can be computed as the commitment fee percent multiplied by the un-drawn balance. The process is the same again as the other circular reference problems. The first step is making the calculations in the excel model. The second step is re-programming the excel functions into a function that contains an iterative loop.

Case 4: Equity Funded before Debt and Backwards Induction

If the owner or sponsor of a project does not provide any guarantee of debt service during construction or if the owner has weak credit, then lenders often require the equity contribution to be funded before the debt commitment is borrowed. When equity is contributed before debt, the equity IRR on a project is reduced because the equity is contributed earlier and must still wait until commercial operation before receiving positive cash flow. Before addressing circular references caused by this funding method, the general mechanics of computing a cascade of debt and equity draws is presented. With priorities of funding, an approach can be used that is similar to the cash flow waterfall mechanics. The key to modelling a cash flow waterfall is to (1) using sub-totals; (2) setting-up criteria for the maximum amount of debt or equity that is available for funding deficit cash flow; (3) making all of the calculations in the cash flow analysis and not in the debt or equity schedules; and (4) using the MIN function with opening balances or criteria derived from opening balances. This time the process begins with cash funding needs and works through the order of the funding.

The schedule and equations below demonstrate how one can set-up a model to compute the equity and debt funding assuming that the equity funding is known in advance. The key to implementing these equations is using the MIN function to compute the amount equity funding before debt funding is applied.

Total Equity Commitment (Project Cost x Equity or Project Cost - Debt Commitment)
Less: Equity Already Funded (Opening Balance of Equity)
Remaining Equity Available for Funding

Opening Equity Balance
Add: Equity Issued from Funding Analysis
Closing Equity Balance

Funding Needs (Construction plus debt service reserve funding plus interest and fees paid)
Less: Equity funding from MIN of Funding Needs and Remaining Equity Available
Subtotal 1: Cash Flow after Equity Funding
Equals: Debt Funding Required

To resolve this calculation, the remaining equity balance must be computed from an equity table which increases with new equity issued in each period. The process illustrated above can be demonstrated using formulas. In these formulas, the total debt commitment can be computed from the total project cost multiplied by the given debt to capital ratio or it can be computed from an analysis of the debt service coverage ratio and the cash flow.

Accumulated Funding Needs = Sum of Construction, DSRA, Interest and Fees Paid

Accumulated Debt Funding = Total Debt Commitment – Capitalised Interest and Fees

Accumulated Equity Funding = Accumulated Funding Needs – Debt Funding

Remaining Equity Commitment_t = Total Equity Commitment – Opening Equity Balance_t

Equity Balance_t = Opening Balance_t + Equity Funded_t

Equity Funded_t = MIN(Remaining Funding_t, Current Funding Needs_t)

Funding a project with equity first occurs causes circular reference problems because the equity commitment depends on the amount of debt funding. However the debt funding requirement is driven by the amount of interest since the given debt commitment less the interest is the definition of funding. Further, the interest and fees are driven by the equity funding because the more the equity funding, the less time the debt is outstanding during the construction period and the less the interest expense. A circular reference problem also occurs when the interest is paid rather than capitalized during construction because if interest is paid, then interest is included in funding requirements. The interest included in funding requirement drives the amount of debt funding and thus the equity funding. The diagram below illustrates how the circular problem arises when there is an equity priority for the funding order and interest is capitalised (funding needs include construction expenditures and debt service reserve funding).

Equity Funding → Funding Needs minus Debt Funding
Debt Funding → Interest Charged, Fees Charged
Interest and Fees → Equity Funding

The circular reference problem and the equations for computing the funding cascade is illustrated in the example below. Note how the interest during construction creates the problem:

S&U Summary				
EPC Cost	100,000.00			
Interest During Construction	-			
Total	108,821.05			
Debt Funded	87,056.84	80.00%		
Equity	21,764.21	20.00%		
Total Capital	108,821.05	100.00%		
Funding Cascade				
Equity Commitment	21,764.21	21,764.21	21,764.21	21,764.21
Equity Funded (Opening Balance)	0.00	21,764.21	21,764.21	21,764.21
Remaining Equity	21,764.21	0.00	0.00	0.00
Opeing Equity Balance	0.00	21,764.21	21,764.21	21,764.21
Add: Equity Funding	21,764.21	0.00	0.00	0.00
Closing Equity Balance	21,764.21	21,764.21	21,764.21	21,764.21
Construction Funding	25,000.00	25,000.00	25,000.00	25,000.00
Interest Paid	0.00	323.58	2,855.94	5,641.53
Total Funding	25,000.00	25,323.58	27,855.94	30,641.53
Equity Funding	21,764.21	0.00	0.00	0.00
Debt Funding	3,235.79	25,323.58	27,855.94	30,641.53

Uses of Funds					
Construction	25,000.00	25,000.00	25,000.00	25,000.00	
Add: Interest Paid	-	323.58	2,855.94	5,641.53	
Total	25,000.00	25,323.58	27,855.94	30,641.53	
Sources of Funds					
Debt	3,235.79	25,323.58	27,855.94	30,641.53	
Equity	21,764.21	-	-	-	
Total	25,000.00	25,323.58	27,855.94	30,641.53	
Debt Schedule					
Opening Balance	-	3,235.79	28,559.37	56,415.31	
Add: Debt Draws	3,235.79	25,323.58	27,855.94	30,641.53	
Closing Balance	3,235.79	28,559.37	56,415.31	87,056.84	
Interest Rate	10%	10%	10%	10%	
Interest Recorded	-	323.58	2,855.94	5,641.53	
Debt Ratio	80.00%				
Function IDC	8,821.05	< ---- =debt_adders(O22,O19:R19,O6:R6)			
Computed	8,821.05				
Difference	0.00				

If the debt commitment is known from the cash flow and a given debt service coverage ratio, the circular reference problem can be solved using a backward induction approach where the closing balance of debt equals the next year opening balance. In this system the last closing balance is established and then the opening balance is reduced and reduced each year until it reaches zero. When the opening balance is pushed back to zero in earlier periods of the construction period, then the equity funding must start and continue for the remaining prior periods of the construction period. The opening balance is the closing

balance of the debt less the draws and the interest, implying the opening balance declines. Eventually the opening balance would be zero and the debt draws must be constrained using a MIN function.

To set-up a backwards moving debt balance table you begin with the closing balance at the end of the construction period. At this point -- at the end of the construction period -- the closing balance should be the given amount of the total debt commitment, including all capitalised interest and fees. When starting with the closing balance, the opening balance is derived from the closing balance in a process the works backwards. This contrasts with the normal case where the closing balance is computed from the opening balance plus the draws and the capitalised interest and fees. Once the opening balance is derived, the amount of debt draws through funding is limited until the opening balance falls to zero. Here the debt funding is independent of the equity balance and a circular reference can be avoided.

If the debt to capital ratio or you do not want to use backward induction, you can develop a function to compute the debt adders (the interest during construction and fees). As with the other functions, you should type the same calculations in the function as are in the spreadsheet. The aggregate sources and uses are computed outside the construction loop. In this case, the order of equations in the function does matter. A completed function where the interest is paid and the debt funding is driven by an input ratio is illustrated in the function below. Note that if you wanted to create a cascade with debt rather than equity issued first, you could develop a similar function.

```
Function debt_adders(Debt_Ratio, Interest_Rate_Array, Construction_Array)

base_project_cost = WorksheetFunction.Sum(Construction_Array)  ' Total project cost without  IDC
number_of_periods = Construction_Array.Count                  ' Construction periods

For Iteration = 1 To 30                                       ' Iteration to find adders

    Total_cost = base_project_cost + accum_idc                    ' Make aggregate calculations outside of construction loop
    Debt_funded = Total_cost * Debt_Ratio                         ' Work through S&U summary
    Equity_Funded = Total_cost - Debt_funded                      ' Equity Funding is starting point
    Opening_Equity_Balance = 0                                    ' Need to initialise variables

    last_idc = accum_idc
    Debt_Balance = 0
    accum_idc = 0
    interest = 0

    For i = 1 To number_of_periods
        Remaining_equity = Equity_Funded - Opening_Equity_Balance              ' How much is left for funding
        interest = Debt_Balance * Interest_Rate_Array(i)                       ' Interest on Opening Balance
        funding_needs = Construction_Array(i) + interest                       ' Add interest to funding needs
        Equity_funding = WorksheetFunction.Min(Remaining_equity, funding_needs)  ' Equity funding from MIN

        debt_draws = funding_needs - Equity_funding                            ' debt draws after equity

        accum_idc = accum_idc + interest                                       ' Accumulate items at the end
        Debt_Balance = Debt_Balance + debt_draws
        Opening_Equity_Balance = Opening_Equity_Balance + Equity_funding       ' Accumulated Opening balance

    Next i

    If Abs(accum_idc - last_idc) < 0.001 Then                                  ' Test for convergence
          debt_adders = accum_idc
          Exit Function
    End If

Next Iteration

End Function
```

Case 5: Bond Financing, No Capitalised Interest, Equity Residual Tranche

If bonds are issued in a project financing, the total draws occur in a single period. As the amount of the bonds will often exceed the funding needs, a bond fund account can be established. Draws from the senior debt are taken from the bond account using a MIN function in an analogous manner to the cascade discussed above. The process begins with the period by period funding needs as in the cases above with the only exception that the interest income is used to reduce the amount of funding needs. The adjustments to the cash balance account include the amount of the bond financing and the use of

cash which is the smaller of the use of the opening balance and the funding requirements. After the bond account is used up, the process is the same as in the other funding techniques; the simplest of which is simply funding with equity.

Setting-up the funding process with bond issues is demonstrated in the step by step instructions below:

Step 1: Begin with total funding requirements that includes a deduction for interest income

Step 2: Create a switch variable for the time period during when the bond is issued

Step 3: Develop a bond cash account that adds the bond financing using the switch and subtracts the funding

Step 4: The funding from the bond cash account is computed using the MIN function illustrated below:

MIN(total funding requirements, opening balance)

Step 5: Compute the interest income on the bond cash account

Step 6: Compute the remaining funding requirements and use one of the above techniques to compute the funding from other sources

In the bond financing case there is no circular reference unless techniques such as the drawdown percentages that are derived from interest expense are used to separate the remaining subordinated debt (or bank debt) funding and the equity funding.

Method 3: Bond Financing

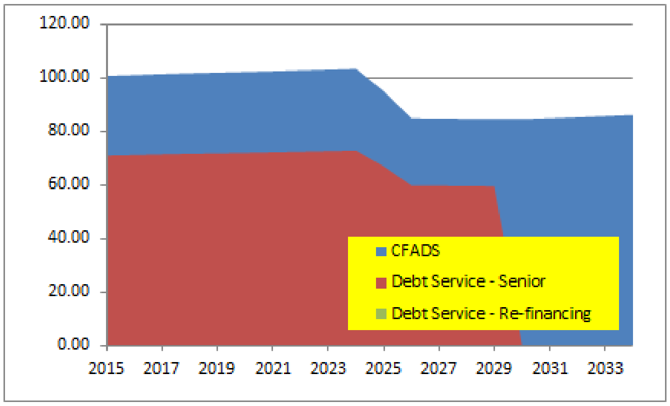
Total Financing Requirements Less Interest Income		5,371,289	13,830,363	22,824,195	14,031,513	5,042,161	-	-	-	-
Bond Financing Date	31-Aug-11									
Bond Financing Amount	52,909,617									
Bond Financing Switch		TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Bond Cash Account										
Opening Balance		-	52,909,617	39,079,254	16,255,059	2,223,546	-	-	-	-
Add: Draws from Financing		52,909,617	-	-	-	-	-	-	-	-
Less: Amounts Used for Funding		-	13,830,363	22,824,195	14,031,513	2,223,546	-	-	-	-
Closing Balance		52,909,617	39,079,254	16,255,059	2,223,546	-	-	-	-	-
Annual Interest Income Rate		2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Periodic Interest Income Rate		0.17%	0.17%	0.17%	0.17%	0.17%	0.17%	0.17%	0.17%	0.17%
Interest Income Amount		-	87,385	64,543	26,847	3,672	-	-	-	-
Remaining Funding Needs		5,371,289	-	-	-	2,818,615	-	-	-	-
Sub Debt Percent		93.33%	93.33%	93.33%	93.33%	93.33%	93.33%	93.33%	93.33%	93.33%
Equity Percent		6.67%	6.67%	6.67%	6.67%	6.67%	6.67%	6.67%	6.67%	6.67%
Sub Debt Financing	7,000,000	5,013,203	-	-	-	2,630,707	-	-	-	-
Equity Financing	500,000	358,086	-	-	-	187,908	-	-	-	-
Total	7,500,000									

Chapter 39: Incorporating Debt Sculpting in a Project Finance Model which is Easy Until Income Taxes are Introduced

Debt Sizing and Debt Sculpting

Determining the debt size and determining the structure of debt repayments are among the most important elements of debt structuring in a model. When structuring debt, you often start with the level of the debt service coverage, the leverage or some other parameter and then backs into the amount of the debt commitment that will make the computed debt service coverage ratio equal the target amount. For example, assume the target minimum debt service coverage to obtain a BBB- rating is 1.4 using base case cash flow. Alternatively, the debt can be sized by evaluating cash flows in the downside case, in which case the target debt service coverage would be lower such as 1.2. A bank may then chose the

lower debt size resulting from the two different DSCR ratios along with the different cash flow scenarios. Transactions often have a debt leverage constraint as well as the coverage constraint. If the debt size results in an unreasonable level of debt leverage such as 95%, then the debt size should be constrained. Debt sculpting is illustrated on the graph below:



If the debt repayment is computed on the basis of annuity payments or equal instalments, then a goal seek process can be used to establish the debt size where multiple trials for the debt commitment are input. If either a level or annuity payment is used, then the DSCR is not constant over the life of the loan unless the cash flow happens to be the same as the debt service over time. Instead of targeting the minimum DSCR and allowing the remaining coverage ratios to increase, the debt repayments can be varied over time so that the DSCR is the same in each period. The notion of deriving the debt repayments together with the debt size to meet a single target or multiple target DSCR ratios is referred to as sculpting.

Debt sculpting seems to be a difficult process, but there are a variety of different ways to compute debt repayments that make the calculation seem quite simple. Four different techniques are reviewed below that demonstrate principle issues in making sculpting calculations. Unfortunately, the simple methods become difficult when taxes and the DSRA income are included in the calculation. The remainder of this section begins by describing the debt sculpting part of structuring a model using artificial case with no taxes and no DSRA account. With this simple example, four different sculpting methods are described to illustrate how the repayments can be computed. After different methods using the no tax case are completed, sculpting techniques in a case with a DSRA account and with taxes are illustrated with backwards induction and a user defined function.

The complexities of programming a debt structure that produces a constant DSCR over the lifetime of debt can be demonstrated in a simple case with no taxes and no DSRA. The first case uses the excel SOLVER to find both the size of the debt and each debt repayment given the pattern of expected cash flow. The second approach uses a little bit of algebra along with the GOAL SEEK function to size the debt and find the debt repayments. The third method uses the fact that the present value of cash flow at the debt interest rate equals the amount of debt initially issued to size the debt along with the algebra from the second method. The fourth method sizes the debt using a backward induction method through setting the closing balance at the end of the debt tenor to zero and then gradually backing into the amount of debt that must be issued to result in the zero closing balance.

Method 1: Use of Solver in Sculpting

To illustrate the alternative sculpting approaches, imagine a simple case where the operating cash flow varies over time and that the operating cash flow equals the CFADS (there is no interest income and no taxes). The general objective of the sculpting process is to adjust the debt repayments so that the DSCR will be constant over time given the varying operating cash flow. After setting up a debt schedule with an arbitrary amount of initial debt, one can imagine using multiple GOAL SEEK functions to compute the

repayment in each period such that the computed DSCR equals the target DSCR. In these cases where multiple GOAL SEEK functions are required, you can use the SOLVER tool that allows you to solve for multiple target cells instead of one cell. When running the solver to find the repayments, the process works nicely to find the debt repayment, but the closing balance of the debt does not reach a value of zero unless you happened to enter an amount of initial debt that happens to repay all of the debt. To make sure that the debt is fully repaid, an additional constraint on top of the DSCR constraints must be entered into the SOLVER that sets the closing balance of the debt to zero. When you add another constraint, an additional target variable should be added that allows the size of the debt issued to change.

The step by step mechanical process for using the SOLVER tool to sculpt is demonstrated below. When entering items in the SOLVER tool, it is not necessary to enter anything into the top section (except when you are recording a macro):

- Add the initial debt issued and an array for the repayment for each period in the CHANGING CELLS or target section of the solver.

- Add a constraint that the computed debt service ratio equals the target debt service coverage ratio.

- Add a constraint that the final debt balance must be zero.

It may be helpful to set-up a macro to re-do the solver with a macro. Unfortunately, this is a bit complex because the visual basic must be adjusted to allow the solver to work. This process involves:

- Step 1: Press the Alt-F11 key to get the visual basic menu
- Step 2: Go to the TOOLS, REFERENCE option and then click on the SOLVER option.
- Step 3: After beginning to record a macro, re-set the solver
- Step 4: Make sure the first part of the solver is not blank
- Step 4: Re-do the solver
- Step 5: Add a Userfinish = FALSE after the SolverSolve

An example of the solver code with the adjusted finish is illustrated below. All of the lines of code except the last line come from simply recording the macro after running the solver.

```
SolverReset
SolverOk SetCell:="$I$5", MaxMinVal:=3, ValueOf:="0", ByChange:="$G$32,$G$46"
SolverAdd CellRef:="$L$2", Relation:=2, FormulaText:="0"
SolverSolve UserFinish = False
```

The solver method is clumsy and performs very slowly in a large model. If you change the tenor of the debt, then you would have to go back to the SOLVER tool and re-enter all of the repayments and the target DSCR arrays. Because of these problems it is doubtful that the method would be used in real models. However, it is useful to discuss the method because it illustrates the various considerations that must be made in setting the repayments and at the same time sizing the debt, particularly the notion that the debt is sized by setting the ending debt to zero.

Method 2: Goal Seek and Algebra

A more elegant solution for sculpting debt is to compute sculpted debt repayments using a formula tied to cash flow and then size the debt with a simple goal seek. The process involves re-arranging the basic formula for DSCR which is the cash flow divided by the debt service along with the formula that debt service is defined as interest expense plus the debt repayments. Using this method, the repayment can be derived as a function of both the DSCR and the operating cash flow as illustrated below (note that this formula can only be applied if the interest expense is computed from the opening balance of the debt, implying that cash flows occur at the end of the period):

DSCR = Cash Flow/(Interest + Repayment)

(Repayment + Interest) x DSCR = Cash Flow

Repayment = Cash Flow/DSCR - Interest

When applying the formula above in a model the repayment does yield the appropriate DSCR. But the above formula does not mean the ending balance of debt at the final repayment date becomes zero. The method is analogous to the first part of the SOLVER method above before adding the additional constraint to set the closing balance of the debt to zero. To deal with the problem of non-zero debt ending debt, a goal seek formula can be used to determine the leverage percent or the total debt commitment in order to set the ending debt balance to zero as illustrated below:

Set Closing Balance to Zero by Changing Initial Debt Issued

It is useful to add a macro to the goal seek so that any time you change an input into the model you can re-size the debt. The only problem with the macro is that the ending debt cell may vary depending on the term of the debt (in many modelling problems, once you open one door to fix a problem, another door appears.) To fix this problem, you can use the SUMPRODUCT function along with a test for the term of the debt as illustrated below:

Goal Seek Debt = SUMPRODUCT(Closing debt balance series x (period = term of debt))

The result of this SUMPRODUCT function can then be used in the goal seek with the macro to establish the debt level that works with the sculpting. While this method is more flexible than the SOLVER method, the approach still requires a GOAL SEEK function and should include a macro. The goal seek must be run after changing any input for operating cash flow, the interest rate on debt, the tenor of the debt or the target DSCR. If you are structuring the model to find a price that will realize an equity IRR target, this means two goal seek functions must be run which limits the flexibility of a model.

Method 3: NPV of Debt Service from and Independent Calculation

An elegant way to solve the sculpting problem is to use the formula [Repayment = Cash Flow/DSCR - Interest] for computing debt repayments and then to use the fact that the present value of debt service equals the value of the debt. In this case the goal seek can be avoided and the model can be used to compute debt sculpting without running a macro. The trick in this calculation is that the present value of the debt service must be independent of interest expense or repayment calculations in the debt sculpting calculation. If the debt service from the sculpting analysis is used to compute the present value of the debt, then the debt service depends on the initial closing balance of the debt, but the closing balance is the present value of the debt. You end up with a hopeless circular reference. The problem can be solved however if the simple idea that the debt service is the CFADS/DSCR is used to compute target debt service and then the present value of the series of debt service is computed to yield the debt issued. Now the calculation of the target debt service is independent of sculpting and present value of the independent debt service yields the closing balance of the debt which is now not dependent on the sculpting calculation. Using this technique, the whole sculpting process can be boiled down to three formulas as illustrated below:

Required Debt Service = (CFADS / Target DSCR)

and,

Total Debt Issued = NPV(Interest Rate, Required Debt Service)

Repayment = Required Debt Service – Interest Expense

The big advantage of this method is that the debt service coverage ratio can be entered as an input and the amount of the debt is established. There is no SOLVER, no GOAL SEELK and no macro. This is what you want to make a model flexible.

When applying the NPV formula, the repayment must only occur in the debt repayment periods. To make this happen, a switch can be created for the debt repayment period. Then the required debt service as well as the repayment can be multiplied by the debt repayment switch. One problem that is manageable is in using the formula is that the NPV formula cannot be used if the interest rate changes over time. In project finance transactions, the credit spread often increases over the term of the debt to encourage re-financing meaning that it is likely the interest rate will change. When computing the present value of the loan with changing interest rates, the normal formula for the discount factor – 1/(1+interest rate) ^ period -- does not work because the compounding effects of earlier changes in interest rates are ignored. To illustrate the problem, assume an extreme case where the interest rate is 50% in the first year and then the rate falls to zero in the second year. Also assume that the CFADS divided by the DSCR is 100 in each year. In this case, the present value of the cash flow using the traditional formula is 166.7 as illustrated below.

PV of Cash Flow = 100/(1.5) + 100/1.0 = 66.67 + 100 = 166.67

If the initial debt balance of 166.7 from this present value formula is applied, then the balance of the debt does not fall to zero, but remains 40 as illustrated below (the sum of the repayment and interest is 100 in each year):

Opening Balance		166.7	140
Less: Repayment		16.7	100
Closing Balance	166.7	140	40
Interest Rate		50%	0%
Interest		83.3	0

The discounting problem occurs because the value of the second 100 cash flow should be reduced by the 50% interest rate in the first period, as you would have to pay 50% interest in the first year if you want to borrow the 100 in the second year. As with other problems when discount rates change you cannot ignore the discounting effects related to the cost of money in the first year. Therefore, the present value and the total debt balance should be 100/1.5 in each year, or 66.67 times 2 or 133.33. The discount factor can be computed by first calculating an index of the interest rate in the same manner as one would compute the index for the inflation rate. After the index is computed, the discount factor is one divided by the index as illustrated below:

$$\text{Index}_t = \text{Index}_{t-1} \times (1+ \text{Rate}_t)$$

$$\text{Discount Factor} = 1/\text{Index}_t$$

When the compound discount factor is used as above, then the discount factor is 1.5 for both years (in the second year the index is 1.5 x 1 or still 1.5 because of the assumption that the interest rate is zero in the second year). Here the total present value of the debt is 133.3 and closing balance of the debt falls correctly to zero.

Opening Balance		133.3	100
Less: Repayment		33.3	100
Closing Balance	133.3	100	0
Interest Rate		50%	0%
Interes Expense		66.7	0

Method 4: Backward Induction

The whole process of sculpting starts with cash flow generated from a project and works backwards to find debt service and then the amount of debt that a project can support in order to repay the debt in the final period. A fourth method that works backward can be used to compute the debt repayments and the amount of debt issued at the same time is beginning with the closing balance of debt rather than the opening balance of the debt. If one begins with the closing balance at the end of the loan tenor instead of the opening balance, then one can work backwards and make the prior period closing balance equal to the subsequent opening balance. This is the opposite of the normal process. The backward induction method does not cause a circular reference problem. Through beginning with zero and working backwards, no net present value formula is necessary, but the debt repayment formula is a bit more difficult. Even if you do not use this method, it is instructive to work through the repayment formula for other aspects of a financial model such as the debt service reserve account.

In setting the closing balance, it is convenient to create a switch for the period of the date of the debt tenor of the loan. For the date of the debt tenor, the closing balance is zero. For all of the other periods, the closing balance is equal to the NEXT period opening balance (in contrast to the normal case in which the opening balance is equal to the PRIOR period closing balance:

Closing debt balance = IF(debt tenor, 0, next period opening balance)

Once the closing balance is set, the opening balance is equal to the closing balance plus the repayments (which contrasts with the normal case in which the closing balance is equal to the opening balance minus the repayments.)

Opening debt balance = Closing debt balance + Debt Repayment

The debt repayments cannot be computed using the formula (CFADS/DSCR – interest) because the required debt service less the interest since the interest depends on the opening balance and the opening balance of the debt is a function of the debt repayment. Instead, a bit more algebra can be used to compute the debt repayment. The revised formula can be derived by calculating interest expense using the debt repayment rather than the opening balance of the debt. To avoid circularity, the interest expense can be computed as function of either the next period interest expense or the closing balance of the debt instead of the opening balance. This is accomplished by recognizing that the opening balance of the debt less the repayments is the closing balance. The alternative interest expense calculations are shown below:

Interest Expense = Opening Balance x Interest Rate

Interest Expense = Closing Balance x Interest Rate + Repayment x Interest Rate

Interest Expense = Repayment x Interest Rate + Next Period Interest Expense

Given the latter definition of interest expense, the repayment can be derived from the debt service and remain be independent of the interest. Since the debt service is given by CFADS divided by the target DSCR, no circular reference problem should be present. The repayment can be computed independently

of the interest expense is illustrated below. All elements that include repayment are moved to the left hand side of the equation:

Required Debt Service = Interest Expense + Repayment

Repayment = Required Debt Service – Interest Expense

Repayment = Required Debt Service – Repayment x Interest Rate - Closing Balance x Interest Rate

Repayment + Repayment x Interest Rate = Required Debt Service - Closing Balance x Interest Rate

Repayment = (Required Debt Service - Closing Balance x Interest Rate)/(1+Interest Rate)

Using the backward induction method the repayment function above is entered for repayments; the closing balance at the debt tenor is set to zero; and the opening balance is computed as the closing balance plus the debt repayment. Starting from the end, the closing and opening balance grow when you go backwards because of the debt repayment and the opening balance at the start of commercial operation is the debt balance.

Sculpting Approaches in Complex Cases with Taxes and DSRA

The CFADS is intended to represent cash flow that is available to pay debt service and should reflect the definition of what is available to pay debt service in a loan document. Revenues that are collected (after working capital changes) are available for paying debt service, but generally only after operating expense are paid and after provisions for reserves that are input into a maintenance reserve account. Generally, taxes paid are deducted from the revenues and interest income earned on reserve accounts is included in the CFADS. A final item that may or may not be included in the definition of CFADS is the changes in the DSRA account that may provide cash or require cash. Inclusion of taxes, interest income and changes in the DSRA complicate the debt sculpting process and highlight the advantages and disadvantages of the methods discussed above.

If there are no taxes and the interest income rate is so low that it can be ignored, one of the latter two methods above can be used. As soon as taxes are introduced, the backwards method has advantages because the NPV formula method uses interest expense and interest expense drives taxes.

Plant Balance			80	280	370	420	420	420	420	420	420
Depreciation			0	0	0	0	42	42	42	42	42
Operating Cash Flow			0	0	0	0	100	120	80	90	95
Less; Taxes			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CFADS			0	0	0	0	100	120	80	90	95
Target DS			FALSE	FALSE	FALSE	FALSE	71.43	85.71	57.14	64.29	67.86
PV Factor		1.00	1.00	1.00	1.00	1.00	1.07	1.14	1.23	1.29	1.35
Debt	528.96										
Funding Percent			0.19	0.48	0.21	0.12	0.00	0.00	0.00	0.00	0.00
Debt Funding			100.75	251.88	113.35	62.97	0.00	0.00	0.00	0.00	0.00
Debt Balance											
Opening Balance			0.00	100.75	352.64	465.99	528.96	494.55	443.46	417.36	373.94
Plus: Funding			100.75	251.88	113.35	62.97	0.00	0.00	0.00	0.00	0.00
Less: Repayment			0.00	0.00	0.00	0.00	34.40	51.10	26.10	43.42	49.16
Closing Balance			100.75	352.64	465.99	528.96	494.55	443.46	417.36	373.94	324.78
Intrest Expense			0.00	0.00	0.00	0.00	37.03	34.62	31.04	20.87	18.70
Interest During Construction	63.35		0.00	6.05	24.68	32.62	0.00	0.00	0.00	0.00	0.00
Depreciation Rate			0.00%	0.00%	0.00%	0.00%	10.00%	10.00%	10.00%	10.00%	10.00%
IDC Depreciation			0.00	0.00	0.00	0.00	6.33	6.33	6.33	6.33	6.33
Taxes			0.00	0.00	0.00	0.00	4.39	11.11	0.19	6.24	8.39

Problem 1: Interest Income

CFADS is used to compute sculpted repayments, but the CFADS depends on interest income from DSRA which in turn depends on debt. The problem of circularity from income associated with DSRA is illustrated below:

Debt	→	DSRA
DSRA	→	Interest Income, DSRA Changes
Interest Income, DSRA Changes	→	CFADS
CFADS	→	Debt

Assuming that the debt service reserve account represents one debt service payment (this is the general case with semi-annual modelling and with a six month debt service reserve account), the following formulas can be used to resolve the problem without a circular reference using the third NPV method above. One of the main tricks is to recognize that the opening debt service reserve account is equal to the debt service as illustrated below:

Interest Income = Opening DSRA Balance x Interest Income Rate

Closing Debt Service Reserve Balance = Future Debt Service

Opening Debt Service Reserve Balance = Current Debt Service

Using the fact that the opening balance of the debt service reserve account is the current debt service, the following formula can be derived to compute the debt service that does not depend on the interest income. In the formulas below DS stands for debt service:

DS = (Operating Cash Flow + Interest Income)/Target DSCR

DS = Operating Cash Flow/DSCR + DS x Income Rate/DSCR

DS - DS x Income Rate/DSCR = Operating Cash Flow/DSCR

DS = (Operating Cash Flow/DSCR)/(1-Income Rate/DSCR)

Using this formula, the debt service can be made independent of the interest income and the present value of the debt service can be used to compute the balance of the debt.

Problem 2: Sculpting with Income Taxes without Depreciation on Capitalised Interest

When income taxes are introduced, the problem of sculpting becomes more difficult to solve since income taxes are deducted in the calculation of CFADS. The problem arises because the amount of debt drives the interest expense which in turn drives taxes. But the taxes affect the CFADS which drives the debt calculation. Unfortunately, a simple equation cannot be used to conveniently solve the problem because interest expense affects taxes but the debt repayment component of debt service does not affect taxes. The problem with taxes and debt sculpting is illustrated below.

Debt and Sculpting	→	Interest Expense
Interest Expense	→	Taxes
Taxes	→	CFADS
CFADS	→	Debt and Sculpting

If a method other than the backward looking approach is applied, the sculpting process requires fixing the amount of total debt to avoid the circular reference. Because the debt is independent of the cash flow, interest expense is a function of the fixed debt and the circularity is removed.

The circular reference can be just about avoided if the backwards method introduced above is modified for incorporation of taxes. Here, an equation can be used to compute repayments that are a function of interest rates as well as tax rates rather than the simple equation above. The process of creating an equation for the debt repayment with taxes is demonstrated below without interest income from the DSRA (which further complicates the equations). To begin the process, define required debt service as a function of CFADS less taxes.

CFADS = Operating Cash Flow - Taxes

DS = (Operating Cash Flow – Taxes)/Target DSCR

Also create a separate equation for taxes that is substituted into the required debt service calculation, where T is the tax rate and then substitute the new tax equation into the debt service equation above and then simplify the equation:

Taxes = (Operating Cash Flow – Depreciation – Interest) x T

DS = (Operating Cash Flow – Operating Cash Flow x T + Depreciation x T + Interest x T)/DSCR

DS = (Operating Cash Flow x (1-Tax Rate) + (Depreciation + Interest) x T)/DSCR

With the debt service calculation above, you can use the same calculation introduced in the backward induction no tax case for interest that is a function of debt repayment. Once this interest calculation is substituted into the debt service formula one can re-arrange the equation and collect the debt repayment terms so that the debt repayment terms and made independent of interest expense. As the backward induction method is used, the closing balance can be part of the equation without creating a circularity problem.

Interest = Closing Balance x Interest Rate + Repayment x Interest Rate

To make the equation manageable, use the abbreviations: RP – repayment; OCF – operating cash flow; DP – depreciation expense; RATE – Interest Rate; CB – closing balance; and, DS – debt service. With these abbreviations, the formula for debt service above is:

$$\text{DS} = \text{Interest} + \text{RP}$$

$$\text{Interest} = \text{CB} \times \text{RATE} + \text{RP} \times \text{RATE}$$

$$\text{Interest} + \text{RP} = (\text{OCF} \times (1-\text{T}) + (\text{DP} + \text{Interest}) \times \text{T})/\text{DSCR}$$

Next, substituting the formula for interest expense into the equation above yields a longer equation that includes interest rate and the repayment:

$$\text{CB} \times \text{RATE} + \text{RP} \times \text{RATE} + \text{RP} = (\text{OCF} \times (1-\text{T}) + (\text{DP} + \text{CB} \times \text{RATE} + \text{RP} \times \text{RATE}) \times \text{T})/\text{DSCR}$$

The final part of the algebra involves collecting the terms with the repayment. After the repayment as been collected, move all items with RP to the left hand side of the equation and finally make an equation for repayment that is independent of the debt service or the interest expense:

$$\text{RP} \times \text{RATE} + \text{RP} - \text{RP} \times \text{RATE} \times \text{T}/\text{DSCR} = (\text{OCF} \times (1-\text{T}) + (\text{DP} + \text{CB} \times \text{RATE}) \times \text{T})/\text{DSCR} - \text{CB} \times \text{RATE}$$

$$\text{RP} \times (1+\text{RATE} - \text{RATE} \times \text{T}/\text{DSCR}) = (\text{OCF} \times (1-\text{T}) + (\text{DP} + \text{CB} \times \text{RATE}) \times \text{T})/\text{DSCR} - \text{CB} \times \text{RATE}$$

$$\mathbf{RP = [\{OCF \times (1-T) + (DP + CB \times RATE) \times T\}/DSCR - CB \times RATE] / (1+RATE - RATE \times T/DSCR)}$$

There is a remaining problem with this method that still produces circularity. The term DP for depreciation is not independent of the repayment because it includes depreciation on interest during construction and fees during construction still cause circularity. The depreciation on interest during construction (and the amortisation of fees) causes a very difficult problem that cannot be solved with the backward induction method. When you define depreciation expense as the total depreciation including depreciation on capitalised interest and amortization of up-front and commitment fees in the above formula, all of the work will still result in a circular reference because the debt sculpting process changes a component of the depreciation expense. The tax effect of interest during construction cannot be resolved by a simple formula and the circular reference problem is illustrated below.

Debt	→	Interest during construction
Interest during construction	→	Depreciation Expense
Depreciation Expense	→	Taxes
Taxes	→	CFADS
CFADS	→	Debt

The equation above also does not work in cases of expected tax loss carryforward. In these cases a user defined function or copy and paste macro must be used.

Problem 3: Taxes Together with DSRA

If there is a debt service reserve account with sculpting and no interest income the problem can be resolved without a circular reference. The size of the debt service reserve account is determined after the sculpting calculation is made and the debt service reserve does not affect the sculpting. However, if interest income is included on the debt service reserve account, the sculpting problem becomes complex.

As can be seen from the equation below, the resolution of circular reference problems involve a long formula that can be painful to type into a program. Further, if there are other items that are tax deductible and other items affect debt service and if there is interest income, then the formula becomes even longer. The formula for repayments is demonstrated below.

RP = [(OCF x (1-T)/DSCR + CB x (R x T/DSCR + R x DP x I x (1-T)/DSCR -R) + (OI + OM) x DP x I x (1-T)/DSCR - OI - OP + (OI + SI) x T/DSCR] /
(1+ R - R x T/DSCR - R x DP x I x (1-T)/DSCR - DP x I x (1-T)/DSCR)

Solving the Difficult Sculpting Problems with a Used Defined Function

Instead of working through the backward induction and the tedious algebra, you can solve the sculpting problem with a user defined function and the iteration loop. After illustrating how this can be done you should be convinced that you can resolve just about any circular reference problem with this method. In the case of sculpting and taxes, there are a couple of an additional complications arising from the depreciation on interest during construction. Debt sculpting drives debt levels, but debt levels drive interest during construction, but depreciation on interest during construction drives taxes and sculpting. This means that you must have a loop around both the prospective cash flows as well as the construction period. It also means there should be two outputs from the function.

In explaining the function, you can divide the analysis into two parts. The first part establishes the debt size given an assumed value for interest during construction. The second part derives the interest during construction given the debt size. To develop a function that resolves the sculpting problem you can create a third function that calls the other two functions and includes the iteration loop. The general structure of the function is demonstrated below. Debt is first computed from the target DSCR, cash flow, taxes and the interest rate and the accumulated interest during construction which is zero in the first pass. Unlike the functions discussed above, this function produces two outputs. This means the function should be defined as a VARIANT and an array should be defined to produce the output.

```
Function scuplt(DSCR, cash_flow, construction, interest_rate, tax_rate, depreciation, construction_period, operation_period) As Variant

Dim output(2)                                 '  Define an array for output of the function

For Iteration = 1 To 30                       ' Put iteration around both functions

    last_debt = debt                          ' Record the prior value

    debt = debt_capacity(DSCR, cash_flow, interest_rate, tax_rate, depreciation, accum_idc, operation_period, last_debt)

    accum_idc = funding(debt, construction, interest_rate, construction_period)

    output(1) = debt                           ' For array function, put outputs into an array
    output(2) = accum_idc

Next Iteration

If Abs(last_debt - debt) < 0.0001 Then
    scuplt = output                            ' Define the output of the function
    Exit Function
End If

End Function
```

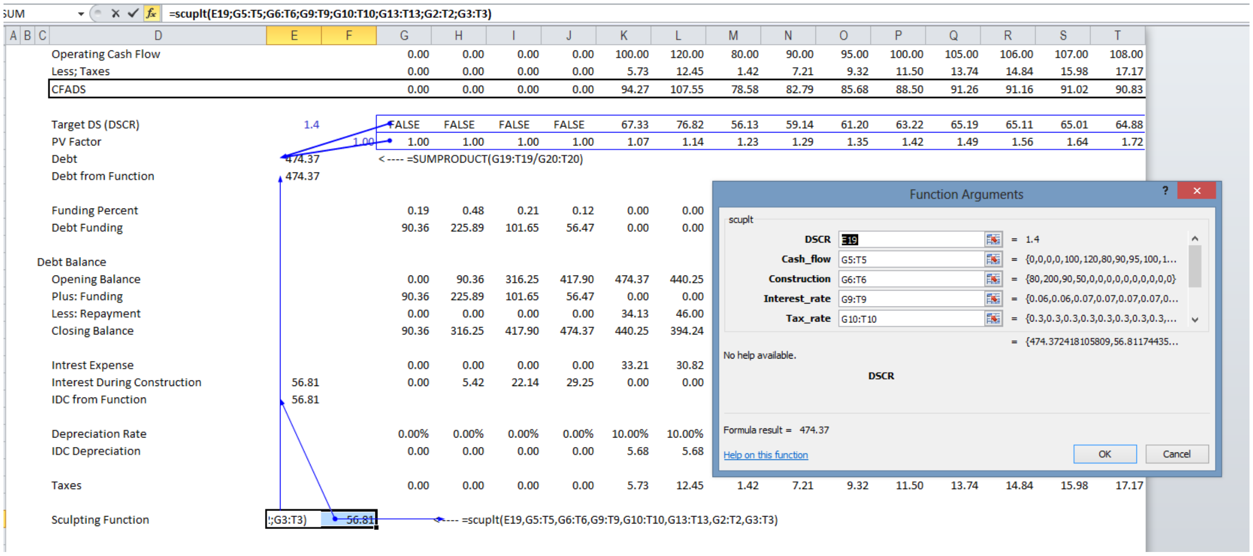
The first function that derives the debt capacity loops through the operating period and derives the present value of the debt. You have to be a little careful about defining the beginning debt balance. You can test this function independently of the combined function (you could add an iteration loop around the debt computation). In writing the function when you read in an array, you need to also be careful about putting the array indices in the code. Note that this function requires the accumulated IDC depreciation as an input.

```
Function debt_capacity(DSCR, cash_flow, interest_rate, tax_rate, depreciation, accum_idc, operation_period, prior_debt)

Total_Periods = cash_flow.Count                                   ' Get the total periods for the loop
Total_Plant = WorksheetFunction.Sum(depreciation)                 ' Use worksheet function for summing an array; need for dep rate

Debt_Balance = prior_debt                                         ' Starting level of debt from prior iteration

PV_factor = 1
debt = 0                                                          ' This is the debt that is computed from the NPV calculation

For i = 1 To Total_Periods
    If operation_period(i) = True Then                             ' Operation period switch
        Interest = Debt_Balance * interest_rate(i)                 ' Compute items like interest for taxes
        Dep_rate = depreciation(i) / Total_Plant                   ' Need the depreciation rate for IDC depreciation
        IDC_dep = Dep_rate * accum_idc

        taxes = (cash_flow(i) - depreciation(i) - Interest - IDC_dep) * tax_rate(i)     ' This is the cause of circularity

        CFADS = cash_flow(i) - taxes                              ' CFADS -- taxes computed later
        Target_DS = CFADS / DSCR                                  ' Target DS for computing the debt level
        PV_factor = PV_factor * (1 + interest_rate(i))            ' Compound PV Factor
        debt = debt + Target_DS / PV_factor

        repayment = Target_DS - Interest                          ' Accumulate Items at the end
        Debt_Balance = Debt_Balance - repayment

    End If
Next i

debt_capacity = debt                                              ' Output the debt for the next increment

End Function
```

The function for computing accumulated interest during construction is essentially the same as the funding functions discussed in the last chapter. In the example shown below, the function is simple with pro-rata funding, no fees and interest paid rather than being capitalised.

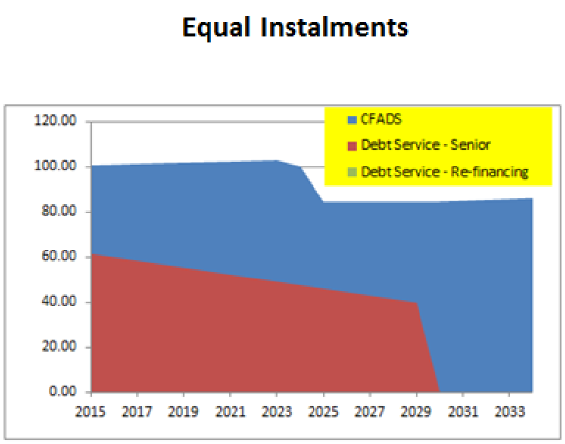
```
Function funding(debt, construction, interest_rate, construction_period)

Total_Periods = construction.Count                                           '  Get total periods
total_cost = WorksheetFunction.Sum(construction)                             '  Total cost
Debt_Balance = 0
accum_idc = 0                                                                ' Be careful to re-set items that accumulate

For i = 1 To Total_Periods
    If construction_period(i) = True Then                                    ' Loop only over the construction period
        If total_cost > 0 Then funding_ratio = construction(i) / total_cost  ' Ratio for pro-rata
        debt_funding = funding_ratio * debt                                  ' Make sure formula is consistent with excel
        Interest = Debt_Balance * interest_rate(i)

        Debt_Balance = Debt_Balance + debt_funding                           ' Accumulate Items at end of the loop
        accum_idc = accum_idc + Interest

    End If
Next i

funding = accum_idc

End Function
```

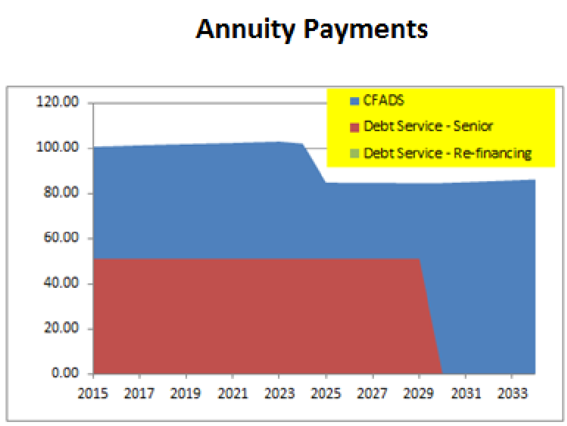
The excerpt below illustrates how to implement the function and how to verify that the function produces the correct results. Recall that you can use the f_x item on the menu to find the name of all of the inputs. Unfortunately when there are more than a few inputs cannot look at them all at the same time on the pop up menu. Note that in this example there is no requirement to use range names. On the illustration below, the debt is computed separately from the function to make sure that your function is correct. A by-product of creating this type of user defined functions is that you are repeating and documenting the excel functions and thereby checking your models.



Chapter 40: Making Functions to Automate the Goal Seek Process for Annuity and Equal Instalment Repayments

Many project finance loans are structured with repayments that are not sculpted to cash flow but rather are repaid in equal instalments or with annuity repayments as illustrated on the graphs below. If the debt commitment is an input to the model and repayments are computed on the basis of either equal instalment payments or annuity payments, then the amount of the total debt capacity can be computed using the goal seek or the solver. However this method leaves many of the same problems as with the copy and paste macros in resolving circular references because a goal seek must be re-run every single time you want any contract or any other aspect of the transaction structure. As with resolving circular references, you can write a user defined function with a few equations to make the simpler repayment styles flexible and dynamic. This chapter reviews how to size debt using the equal instalment and the annuity using the goal seek and then describes the user functions.





Debt Sizing with Level Re-payments or Annuity Re-payments

The target minimum DSCR is an input to structuring and the debt commitment is derived to yield the minimum DSCR given equations for the debt repayment. If equal instalment is used, the debt repayment

is simply the total debt commitment divided by the term of the debt. If the annuity repayment is used, the PPMT function can be used to compute repayments as a function of the period of the model, the total debt term, and the current amount to repay. If you use the goal seek to find the debt size that produces the input DSCR, you can create a macro around the goal seek using the following steps:

- Enter the target debt service coverage in the model and name the range using the SHIFT, CNTL, F3 keystrokes;

- Turn on the record macro button and then use the goal seek process to set the minimum debt service coverage ratio computed in the model by changing the debt commitment;

- Modify the recorded macro through using the macro edit button or the ALT, F11 short-cut;

- When editing the macro, you will see code that defines the goal seek process. To edit the macro, replace the fixed number with the cell reference for the target input DSCR;

  Before: Range("F14").GoalSeek Goal:=1.5, ChangingCell:=Range("F4")

  After: Range("F14").GoalSeek Goal:=Range("F20"), ChangingCell:=Range("F4")

  Replace the cell references with range names in the macro (a practice that should always occur because otherwise the macro will not work when you insert or delete rows);

  Range("C_DSCR").GoalSeek Goal:=Range("Target"), ChangingCell:=Range("Debt")

  Create a spinner box that is linked to the target debt service coverage ratio (you will have use the cell link to an open cell and then divide the cell by 100).

  Attach the macro to the spinner box, through right clicking on the spinner box.

Computing Debt Size for Equal Instalment with User Defined Function

To compute the debt size in the equal instalment case, you can loop around the operating periods and compute the DSCR in each period. Then you can compute the minimum DSCR by comparing the current period DSCR to the minimum DSCR. After finding the minimum DSCR, you should save the cash flow and the number of the period of the minimum DSCR. This part of the process is illustrated below:

```
  Tax_loss = 0
  NOL_Used = 0

  If (EBT <= 0) Then
      Tax_loss = 0 - EBT
      NOL_Balance = NOL_Balance + Tax_loss
  End If

  If (EBT >= 0) Then
      NOL_Used = WorksheetFunction.Min(EBT, NOL_Balance)
      NOL_Balance = NOL_Balance - NOL_Used
  End If

  Adjusted_EBT = EBT + Tax_loss - NOL_Used

  Taxes_Paid = Adjusted_EBT * Tax_Rate

Compute the CFADS and the DSCR so can find the minimum DSCR over the entire period

  cfads = EBITDA - Taxes_Paid + interest_income - MRA_Funding_Array(i)                       ' MRA funding affects CFADS but not taxes

  Level_Repay = Base_Debt_Balance / term

  Debt_Service = Interest_Expense + Level_Repay

  If (Debt_Service > 0) Then
      If Debt_Service > 0 Then DSCR_Period = cfads / Debt_Service        ' Compute period by period DSCR
  Else: DSCR_Period = 100
  End If

  If DSCR_Period < min_DSCR Then                                        ' Find the minimum DSCR
      min_DSCR = DSCR_Period
      min_yr = Period
      min_CFADS = cfads
      int_rate_min = Int_Rate                                           ' Find the interest rate during the minimu DSCR period
  End If

  Opening_Debt_Balance = Opening_Debt_Balance - Level_Repay              ' Adjust the debt balance for the next period
```

Once the minimum DSCR and the cash flow in the minimum period has been established, you can use the following formulas to compute the debt balance:

In the first period: Repayment = Debt Balance/Debt Tenor

In later periods: Repayment = Remaining Debt Balance/Remaining Tenor
Repayment = (Opening Balance - Yr of Debt x Repayment)/(Tenor-Yr of Debt)c
Repayment + Yr x Repayment/(Tenor-yr) = Opening Balance/(Tenor-Yr)
Repayment x (1+yr/(Tenor-yr) = Opening Balance/(Tenor - Yr)
Repayment = [Opening Balance/(Tenor-Yr)] / (1+yr/(Tenor-yr)

Once you have the repayment, you can compute the opening balance that yields the DSCR in the minimum DSCR period. Then you can re-run the year by year loop and make sure the year of the minimum DSCR does not change. Computing the debt size from the minimum DSCR is demonstrated below where:

DSCR = Minimum CFADS/Debt Service

meaning,

Debt Service = Minimum CFADS/DSCR

```
'
' Re-compute the debt balance from the minimum DSCR
'

   factor1 = min_CFADS / DSCR
   factor2 = (int_rate_min * (term - min_yr + 1) + 1) / term

   factor = factor1 / factor2

   debt_balance = factor
```

Computing Debt Size for Annuity with User Defined Function

Calculating the debt size in the annuity case is equal instalment case is somewhat easier than the equal instalment case because the debt service does not change over the life of the loan. That means the year of the minimum debt service is defined by the operating cash flow and is independent of the year. Once you have computed the period of the minimum cash flow, you can use the logic below to derive the level of the debt. The only reason you may need an iteration loop is because of the tax problem where taxes drive the CFADS.

Debt Service = Debt x Payment Percent

DSCR = Minimum CFADS/Debt Service or Debt Service = Minimum CFADS/DSCR

Therefore, Debt x Payment Percent = Minimum CFADS/DSCR

Implying, Debt = [Minimum CFADS/DSCR]/Payment Percent

Where, Payment Percent = PMT(Rate, Debt Tenor, -1.0)

Chapter 41: Misery Caused by Debt Service Reserve Accounts and a Few Tricks to Make the Process Easier

Project finance loans and some leveraged buyout loans include requirements to put cash aside in a bank account to assure that there is a buffer to meet prospective debt service requirements. A typical requirement in project finance is that the next semi-annual debt service payment must be held in an account that should be available as a buffer. Such an account assures that temporary blips in cash flow will not cause a default and assures that if something bad happens and the debt needs to be restructured, that sufficient time is available to make arrangements. For owners of the company, the problem with locking up cash in this manner is that holding cash on the balance sheet and earning a return much lower than the overall equity return can be very expensive in terms of the rate of return on equity. For example, if a project borrows money at a rate of 7% to fund the DSRA and then puts the borrowed money right back into the bank, it may receive interest income at a much lower rate, say 1.5%. This low income rate relative to the interest expense rate can have a big negative effect on the equity IRR, particularly in the case of projects with tight coverage. An alternative to holding cash in a debt service reserve account is to acquire a letter of credit. In this case a commitment fee must be paid, but the project does not experience the cost of borrowing money at a high rate and earning a much lower rate. Further, with the letter of credit, the more debt can be issued for the construction expenditures.

Issues associated with the debt service reserve account can cause major headaches in modelling but they do not have to if the structure of the DSRA equations are structured in a careful manner. The debt service reserve account is often associated with some kind of long macro that copies an entire row in a model. This section demonstrates that circularity is not inherent in modelling the debt service reserve account if the debt level is driven by the debt service coverage ratio (e.g. sculpting) and that a couple of tricks including separating construction debt from permanent debt can sometimes reduce circularity problems.

Debt service reserve accounts can present tricky modelling issues from a technical standpoint because the debt service is computed on a prospective basis. Since the debt service reserve balances depend on the next period debt service and the next period cash debt service may depend on debt service reserve cash flow, a difficult circularity problem seems to arise. Other programming issues with the DSRA include: (1) computing changes in the debt service reserve account on a period by period basis that arise from changes in debt service; (2) calculating uses of the debt service reserve account in a cash flow waterfall when there is deficit cash flow; (3) building-up the debt service reserve account from cash flow in a project; (4) withdrawing amounts from the debt service reserve account as debt service changes; (5)

adjusting amounts to the debt service reserve that arise from a cash flow sweep; and (6) transferring amounts from reserve built up during the construction period.

In general, cash in a debt service account should be modelled in an analogous manner to debt obligations meaning that an account with an opening balance, additions and subtractions, a closing balance and interest income (instead of interest expense) are set-up. Before setting up the reserve account you should establish the required amount that should be in the debt service reserve. Since the DSRA balance should equal the required balance, the net inflows to the account can be established where by the inflows are the opening balance less the required balance. Steps to compute the debt service reserve account are described below:

Step 1: Compute the amount of the required balance of the debt service reserve account from the next period fixed debt service (you can make two rows – one for the current debt service and another for the next period debt service). If you are working with a monthly model, you can use the OFFSET function to look ahead when computing the future debt service. The prospective debt service should be independent of interest expense reductions that arise from the current period cash sweep.

Step 2: Subtract the opening balance of the DSRA balance (computed below) to determine positive or negative amounts that that are required to be deposited or can be withdrawn from the account -- the required funding. In period before construction ends, the required debt service is the debt service from the first operating period and the opening balance of the DSRA is zero, implying that the required funding is the first period debt service.

Step 3: Set-up the opening balance, deposits and removals from the DSRA account. Include a line item for withdraws from the account that are used to fund deficit cash flow.

Step 4: In structuring the funding needs and sources and uses of funds analysis, include the amount required to be funded in the DSRA. This can be computed by multiplying the required DSRA funding in step 2 by the construction phase switch.

Step 5: When laying out the cash flow waterfall, include a line item for net inflows into debt service reserve (note that this amount can be negative when amounts are withdrawn from the reserve account.) Compute a sub-total line in the cash flow statement named something like the cash flow before debt service reserve account flows. If this amount is positive, then the DSRA can be funded (or amounts can be withdrawn) up to the amount that is required as illustrated below:

MIN(MAX(cash flow for DSRA,0), Required DSRA Funding)

Step 6: In the cash flow waterfall include a subtotal line after the payment of debt service to reflect the potential for negative cash flows that arise. Once the negative cash flows are computed, evaluate whether the amount can be met from the reserve balance. The formula for with-drawls from the DSRA to meet deficit funding is:

MIN(opening balance of DSRA, MAX(-cash flow,0))

The set-up of a DSRA account with required balances, required top-ups is illustrated below.

Start of period / End of period / Year (Show Comments · Fix Debt · Sensitivity Cas · Model ok)	01-juil-14 31-juil-14 2014	01-août-14 31-janv-15 2015	01-févr-15 31-juil-15 2015	01-août-15 31-janv-16 2016	01-févr-16 31-juil-16 2016	01-août-16 31-janv-17 2017	01-févr-17 31-juil-17 2017	01-août-17 31-janv-18 2018
Debt Service Reserve and Dividend Lock-up Reserve								
Debt Service Reserve Account								
Debt for Interest	773.43	748.46	732.91	707.00	690.52	663.62	646.18	618.26
Interest on Opening Balance	0.00	15.47	14.97	14.66	14.14	13.81	13.27	12.92
Scheduled Repayment	0.00	24.97	15.55	25.91	16.47	26.90	17.45	27.92
Total Debt Service for DSRA	0.00	40.44	30.52	40.57	30.61	40.71	30.72	40.84
Required Balance	40.44	30.52	40.57	30.61	40.71	30.72	40.84	30.78
Required topup	40.44	-9.92	10.05	-9.96	10.10	-9.99	10.12	-10.06
Opening Balance	0.00	40.44	30.52	40.57	30.61	40.71	30.72	40.84
Less withdrawals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Add: Funding at Construction	40.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Add: Net Topups	0.00	-9.92	10.05	-9.96	10.10	-9.99	10.12	-10.06
Closing Balance	40.44	30.52	40.57	30.61	40.71	30.72	40.84	30.78
DSRA Funded at Construction	40.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Required Top-up After Construction	0.00	-9.92	10.05	-9.96	10.10	-9.99	10.12	-10.06

Avoiding Circular References in funding DSRA through Separating Construction Debt from Permanent Debt

The level of the DSRA depends on the debt commitment which in turn either depends on the project cost or the cash flow. If the DSCR is used to size debt then you should understand that cash flow (except for the interest income which was addressed above in the sculpting discussion) does not depend on the DSRA. Despite this fact shown in the diagram below, the DSRA often seems to result in hopeless circularity. This circularity generally creates a messy copy and paste macro that makes the model a lot less flexible. The diagram below shows that if the DSCR drives debt capacity through cash flow, then the DSRA does not affect CFADS and does not cause circularity (note that interest income does cause a mess). The debt funding drives the debt service which in turn drives the size of the DSRA. However this is not a real circularity problem because the debt commitment is independent of the DSRA and in terms of funding during construction, the DSRA simply re-allocates the funding between construction and other uses.

Debt Service Reserve	→	Debt Sculpting
Debt Sculpting	→	Operating Cash Flow (CFADS)
CFADS	<>	Debt Service Reserve

Some problems of circularity associated with the DSRA and the funding process can be avoided by separating the construction financing from the term or permanent financing after the construction period. The debt service is driven by the term financing and the amount of debt in the term financing must be determined by the independently computed debt commitment from the sculpting analysis which comes before calculations of funding. The process of avoiding circularity associated with the DSRA is the following:

Step 1: Separate the construction debt from the term debt through creating two different loan facilities. The construction loan is paid off at the period before the commercial operation date. For the construction debt, the repayment at the end of the construction period can be modelled using a timing switch and summing the opening balance plus draws and capitalised interest and fees for the period just before commercial operation.

Debt repayment = (Opening Balance + Draws + Capitalised Interest and Fees) x Switch

Step 2: Create a separate account for term debt where the amount of the loan that is issued comes not from the payoff of the construction debt but comes from the loan commitment defined by the sculpting process. When you make the debt issuance for the term debt independent of the construction debt much of the circularity problems are reduced.

Term Debt Issued = Commitment from Sculpting x Switch for End of Construction

Step 3: Include the DSRA in the funding requirements that drive the amount of debt and equity financing (or assume that the DSRA is entirely funded by debt). When the DSRA is included in the funding requirements, then a circular reference does not arise because the DSRA comes from the debt commitment and does not have anything to do with the financing itself.

Funding = Construction + DSRA Funding Needs x Funding Switch

Trying to Avoid Circular References due to Cash Flow Sweeps and the DSRA

A cash flow sweep seems to create an impossible circular reference in modelling the DSRA because the prospective interest expense depends on the end of period debt balance which is driven by the current year cash flow that depends on the DSRA itself. If there is a cash flow sweep, the ending debt balance is reduced from cash flow that affects the next period interest expense. The reason this is not necessarily a circular reference is that DSRA provisions in the loan agreement should not require a forecast of uncertain prospective cash flow in order to project the interest expense and then size the DSRA. Rather, the real information available for sizing the DSRA is the interest expense computed from the opening balance of the loan.

By thinking about the formula for the next period debt service, the circular reference problem can be eliminated. The current level of interest is the beginning balance of the debt multiplied by the interest rate. In the next period, the interest expense declines as the debt is repaid. This means that the next period interest can be defined as the opening balance of the debt less the next period repayments multiplied by the next period interest rate.

Current period Interest = Opening Debt Balance x Interest Rate

Next Year Interest = Closing Debt Balance x Interest Rate (Next Period)

Next Year Interest = (Opening Debt Balance – Repayment) x Interest Rate

The last equation above is the crucial calculation for the debt service reserve calculations in the presence of a cash flow sweep. Using this equation as the interest component of future debt service where the debt repayment does not depend on the future cash flow (which should be the case because the debt service reserve calculation does not depend on the estimating cash flow) then the next year interest does not depend on the cash flow. Further, the debt repayment should be fixed in advance as a function of the sculpting process.

Chapter 42: Modelling Approaches for Maintenance Reserve Accounts where Different Expenditures Occur in Different Periods

In project financing and some other transactions, lenders require cash reserves to be set-up to accumulate money for the prospective payment of major maintenance expenditures. Examples of such expenditures include the overhaul of a wind turbine or the periodic re-surfacing of a toll road. Holding these reserves in a separate account generally cause the rate of return on equity to be a lot lower as the earnings on the cash account should be much less than either the equity return or the borrowing interest rate (the cash is sleeping). The developer of a project can complain that he must pay an interest rate of seven percent to borrow money that is put right back into the bank and only earns an interest rate of two percent. At first blush it seems that the modelling of these reserves is not too complex – one can just add a switch for the maintenance period and then assure that enough money is accumulated in the reserve accounts to assure that funds will be available to pay for the maintenance. Unfortunately, there are pesky programming issues with testing for the maintenance period, computing the contributions to the reserve by looking forward to the prospective maintenance period, and adjusting for the final portion of the loan

tenor after which maintenance will not be required. Programming techniques that are useful for calculating the reserves include establishing a switch for the maintenance period, creating a counter to track the remaining periods until the next expenditure, using the OFFSET function to find the prospective amount of money required for the reserves and using the debt repayment so that contributions do not occur for expenditures after the debt is repaid.

Case 1: Simple Case with Constant Time Period Increments and Constant Expenditures

To demonstrate programming issues associated with maintenance reserve accounts, consider a simple case without complications of: (1) changing maintenance expenditures in future periods; (2) the final expenditures occur in a different period from the final debt payment; and (3) there are varying time periods between expenditures. In this case the OFFSET function is not necessary and the principal issue involves simply finding the period of the expenditure. The inputs for this case are the amount of the expenditure and the time period between expenditures. In this simple case where maintenance occurs on a regular basis and the amount does not change, the step by step process includes:

Step 1: Calculate a switch variable for the maintenance period. To do this you can create a switch that uses the MOD function that computes the remainder between two numbers. The MOD function can be used with the variable that measures the age of the project and the maintenance period as illustrated below. When the MOD function is zero and there is no remainder then the switch is TRUE. This switch is referred to as the MOD switch in the discussion below.

MOD(period, maintenance period) = 0

The MOD switch can be adjusted to only be turned on during the operating period. This can be accomplished through multiplying the first switch by the operating period as illustrated below:

Maintenance Switch = MOD switch x Operating Period Switch

Step 2: Compute the spend amount and the contribution to the MRA

Once the maintenance switch is computed, the total amount actually spent as well as the contributions to the MRA can be established. The total amount spent is simply the constant expenditure input multiplied by the maintenance switch. Periodic contributions to the maintenance are the total amount spent divided by the time periods between the expenditures. This amount should also be multiplied by a debt repayment switch as contributions are not generally required for expenditures that occur after debt repayment.

Case 2: Case with Constant Time Period Increments and Changing Expenditures

If the expenditures are not the same in each period -- for example expenditures increase with inflation -- then the problem of determining MRA contributions becomes a lot more complex. The complexity comes about because of the necessity to look forward to see what to expenditures will be so that you can then determine current contributions to the reserve account. Beginning at the commercial operation date, when cash flow is first generated, contributions to the MRA should reflect the next expenditure which may occur in five or more years into the future. When you must look forward or backward from a cell, the OFFSET function can be useful. In order to use the OFFSET function, the number of periods until the next expenditure should be counted. For example, if the number of periods between expenditures is ten (five years with semi-annual modelling), then a counter beginning with one and ending with ten should be established. Once the counter is developed, this number should be subtracted from the total time periods between the expenditures yielding the remaining periods until the expenditure. In this way, the remaining periods until the next expenditure should be zero for the period of the expenditure.

The MRA contribution can be adjusted so that no funding is made for expenditures that occur after the debt repayment period. To do this, the amount of the expenditure can be multiplied by the debt repayment switch before the OFFSET function is used. Through adjusting the basis for the OFFSET

command by the debt repayment switch, the last expenditure does not have to be in the final debt repayment period. Finally, a test variable can be established to make sure the MRA balance is zero at the end of each spend period. Steps to accomplish the MRA contributions and withdrawals with varying expenditures are shown below:

Step 1: Use the MOD function as above to determine the spend periods

Step 2: Enter the time periods between expenditures as a row in the spreadsheet

Step 3: Use the spend period switch as the basis for computing the number until the next spend. As with the period counter used in computing the age variable, re-set the counter variable one when an expenditure occurs. For the counter to accumulate to the time period between expenditures, a counter variable can be created as illustrated below.

Counter = IF(spend switch, 0, last counter + 1)

Step 4: Compute the periods until the next spend as the total periods between expenditure minus the period counter above. This variable is necessary for the OFFSET function.

Remaining Periods = Total Periods Between Spend - Counter

Step 5: Calculate the total expenditure using an inflation rate through multiplying the total inflated expenditure by the inflation index. This expenditure should be multiplied by the debt repayment switch so that no reserve is accumulated for expenditures after the debt is repaid.

Spend Subject to MRA = Expenditure x Debt Repayment Switch

Step 7: Use the OFFSET function to compute the required future expenditure. The OFFSET function can be developed by using the adjusted expenditure as the reference cell and then moving to the right by the remaining periods until the next expenditure.

Prospective Expenditure = OFFSET(Spend Subject to MRA,0,remaining periods)

Step 8: Divide the future required expenditure by the total number of periods between the expenditures. Use an IF test to assure that a divide by zero does not occur.

MRA Contribution = Prospective Expenditure/Periods Between Spend

Step 9: Compute the MRA balance and then make a test variable to assure that the account goes to zero in the spend period. The formula for this test is illustrated below.

Test = IF(Spend Switch, Closing MRA = 0, TRUE)

Case 3: Case with Varying Time Period Increments and Changing Expenditures and using the MATCH function

The above example assumed expenditures were made in identical time increments and does not allow varying time periods to be made between expenditures. If the expenditures occur with varying time periods as illustrated below a different method can be used to solve the problem. Instead of simply entering the time period between expenditures as an input, it is important to enter specific dates beginning with the commercial operation date. In the example below the number of periods is input n the right and this drives the dates on the left. For example, if there are ten periods between commercial operation and the first expenditure but there are five periods between the first and second expenditure, then the time period for the first expenditure should be ten and not five.

Date	Expenditure	Periods From Prior
1-May-12		
1-May-17	3,000	10.00
1-May-23	3,500	12.00
1-May-27	3,300	8.00
1-Nov-34	4,200	15.00
1-Nov-39	3,500	10.00
1-May-47	2,000	15.00

Given that the time period between expenditures varies, the MOD function cannot be used in this example. To find the expenditure period, a MATCH function can be used with the FALSE switch by comparing the dates in the input table (as illustrated above) to the start of period date in the model. When results of the result of the MATCH is a number rather than a #N/A, a maintenance spend period is occurring. If the result of the MATCH is #N/A then there is no expenditure. If you want a TRUE/FALSE switch for the maintenance period, you can add another row using the ISNUMBER function. When there is a number, the ISNUMBER function produces a value of TRUE and for the #N/A values the ISNUMBER produces a value of FALSE.

Solving the MRA problem with varying periods and varying expenditures can be accomplished without the OFFSET function. Instead you have to use the MATCH and INDEX functions in different ways. Steps of the process are summarized below.

Step 1: Use MATCH function with the FALSE switch combined with the start of period date at the top of the model to find the expenditure for the period. In periods other than the spend period the result is #N/A.

MATCH of Expenditure Date = MATCH(Start Period in Model, Series of Dates in Table, FALSE)

Step 2: Create a SWITCH variable for the maintenance spend period (TRUE if a spend period) by using the ISNUMBER function from the result of the MATCH function above.

Maintenance Switch = ISNUMBER(Match of Expenditure Date)

Step 3: Compute the maintenance expenditure with the INDEX function together with the match of the maintenance date. To avoid a #N/A in the sheet, use an IF statement rather than multiplying by the switch as illustrated below. Note that the actual expenditure should be distinguished from the expenditure subject to an MRA reserve account.

Maintenance Expenditure = IF(Maintenance Switch, INDEX(Expenditure Series, Match of Exp Date)

Step 4: Compute the maintenance expenditure subject to the MRA. After the debt is re-paid there is no need to put money aside in the MRA. The MRA is only necessary to make sure that the project will not have to borrow money to pay expenditures when a loan is outstanding. To make this adjustment, simply multiply the maintenance expenditure by the debt repayment switch.

Maintenance Expenditure Subject to MRA = Maintenance Expenditure x Debt Repayment Switch

Step 5: Compute the periods until the next expenditure. To do this use the MATCH function again, but this time with the TRUE switch instead of the FALSE switch. The This will produce a number that corresponds to the row of the table above.

Maintenance Row Number = MATCH(Start Period in Model, Series of Dates in Table, TRUE)

Step 6: Compute the periods to the next maintenance expenditure through using the INDEX function with maintenance row number computed from the last number above. When you use the INDEX function, the array for the index should begin with the second row date in the table. The prior date is used because the periods from the prior expenditure should change in the period after the spend switch.

Periods to Next Maintenance Spend = INDEX(Prior Period Array, Maintenance Row)

Step 7: Compute the next period expenditure amount that will be subject to the maintenance expense using the Maintenance Row and the debt repayment switch. This requires a two step process that uses the INDEX function and the debt repayment switch. An effective method is to adjust the input table for the debt repayment.

Next Maintenance Spend = INDEX(Next Expenditure Array x Debt Repayment, Maintenance Row)

Step 8: Compute the contributions to the MRA through dividing the next period maintenance expenditure by the periods to the next period expenditure.

Step 9: Compute a table of the MRA with an opening balance, contributions, with-drawls and a closing balance and make a test to assure that the closing balance does not decline below zero.

An illustration of the process for computing the maintenance reserve is shown on the table below.

Start of period	Show Comments	Fix Debt	Base Case	01-sept-24	01-mars-25	01-sept-25	01-mars-26	01-sept-26	01-mars-27	01-sept-27	01-mars-28
End of period			Model ok	28-févr-25	31-août-25	28-févr-26	31-août-26	28-févr-27	31-août-27	29-févr-28	31-août-28
Year				2025	2025	2026	2026	2027	2027	2028	2028
Replacement of Inverters											
Replacement Period for Inverters	Test	Real Cost		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	1.00	#N/A
Expenditure for Inversters without Inflation	USD/kW	517.25		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	465.52	#N/A
Inflation Index	Index			1.23	1.24	1.26	1.27	1.28	1.29	1.31	1.32
Inflated Expenditure	USD 000's			-	-	-	-	-	-	608.24	-
Total Expenditures	USD 000's			-	-	-	-	-	-	303.63	-
Maintenance Reserve Accounts											
Extraordinary Maintenance Expenditures				-	-	-	-	-	-	303.63	-
Match of Next Period (Using 1 as code -- Maintenance Expenditure Period)				1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00
Subsequent Period Maintenance Expenditure				303.63	303.63	303.63	303.63	303.63	303.63	-	-
Maintenance Period (Counter from the last period)				26	26	26	26	26	26	14	14
Required MRA Funding				11.68	11.68	11.68	11.68	11.68	11.68	-	-
MRA Balance											
Opening Balance				233.57	245.24	256.92	268.60	280.28	291.96	303.63	-
Add: MRA Funding				11.68	11.68	11.68	11.68	11.68	11.68	-	-
Less: Expenditures				-	-	-	-	-	-	303.63	-
Closing Balance				245.24	256.92	268.60	280.28	291.96	303.63	-	-

Chapter 43: Including Flexible Re-Financing in a Model and Valuing a Project at Different Stages

After a project had demonstrated stable cash flow, it may be able to pay off existing debt and issue new debt with more advantageous provisions. Re-financing the debt that was originally used to finance the project can have large effects on the economics of a project. If the project meets or exceeds its expected cash flow after a few years, the risk may have diminished a lot. When lenders make their due diligence, some real history is generally much more valuable than the cash flow projections made by a consultant and they may accept a lower DSCR, a longer tenor, less burdensome DSRA provisions and lower credit spreads. If you make a model of a project and ignore potential benefits from re-financing you have not made a real analysis of the returns on the project.

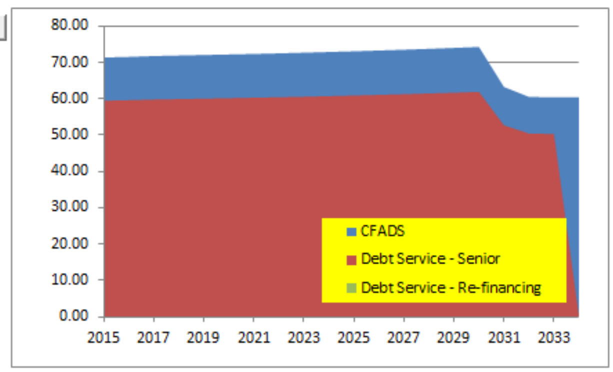
The problem with modelling re-financing is that you do not know: (1) when the re-financing will occur; (2) what sort of metrics lenders will use (such as the DSCR) will lenders use to determine the size of the new loan; (3) what will be the terms of the new debt such as the length of the debt; (4) what kind of fees will be charged for the new loan; and (5) will there be multiple re-financings. All of these uncertainties imply that if you include re-financing in your model, you should make techniques very flexible so that all sorts of re-financing terms can be incorporated.

Re-financing is particularly important in situations where the original loan is repaid relatively early and/or the terms of the first loan are not very attractive. By contrast, if the DSCR on the original loan is low and the tenor of the loan is long and sculpting is used, there is not much upside from the re-financing. Instances where re-financing can be attractive may occur with relatively new technology or in countries that do not have much history in project financing. To illustrate the effects of re-financing, the graphs below show a case with and without re-financing assuming two different initial financing structures. In the first case, the original financing was aggressive with a 1.2x DSCR used to size the debt, a debt tenor of 19 years; sculpting and DSRA structured with a letter of credit. In this case, the project IRR of 5.36% is increased to 20.65% because the all-in cost of debt is less than the after-tax project IRR. By including the user-defined functions for sculpting and funding, you can easily change the debt structuring and examine the type of contract price that is acceptable given the financing structure.

Model Mode: (•) Structuring ( ) Risk Analysis — Fix Debt

Returns	Nominal	Real	MIRR
Pre-tax Project IRR	6.14%	2.89%	6.90%
Post-tax Project IRR	5.36%	2.12%	6.82%
Debt IRR before Tax	4.18%	0.98%	6.69%
Debt IRR after Tax	3.37%	0.21%	6.59%
Equity IRR	20.65%	16.90%	7.60%

Credit	Inital Debt	Re-Finance
Minimum DSCR	1.20	0.00
LLCR	1.20	
PLCR	1.24	

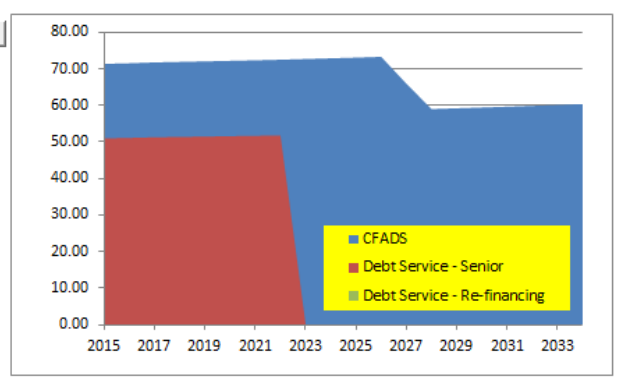


In the second case, the same operating cash flows are used, but a less aggressive financing structure is assumed. The debt tenor is eight years; the DSCR target is 1.5; level repayments are applied and a six month DSRA is imposed. With this financing structure, the equity IRR falls to 5.56% as illustrated below. When re-financing is added to the two scenarios the financial implications are very different. If a new financing with a 1.15x DSCR, sculpting and a tenor that allows a one-year buffer before the end of the project life is assumed, the equity IRR increases to 21% in the aggressive financing case. On the other hand, if the same re-financing is assumed in the conservative financing case, the equity IRR increases form 5.56% to 7.49%. Some people argue that including re-financing in a model is speculative because you do not know what the financial markets will be like in the future, But you could just as well argue that making an assumption of no re-financing is a bad assumption.

Model Mode: (•) Structuring ( ) Risk Analysis — Fix Debt

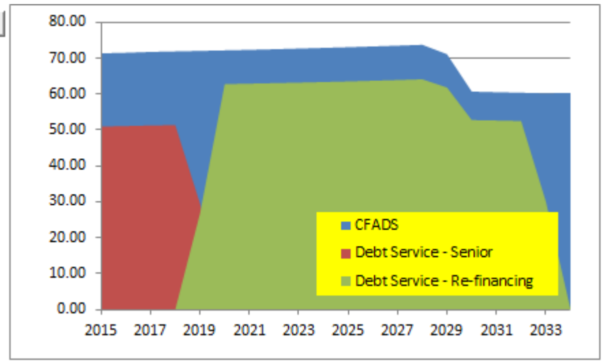
Returns	Nominal	Real	MIRR
Pre-tax Project IRR	6.14%	2.89%	6.90%
Post-tax Project IRR	5.36%	2.12%	6.82%
Debt IRR before Tax	4.37%	1.03%	6.86%
Debt IRR after Tax	3.56%	0.25%	6.81%
Equity IRR	5.56%	2.35%	6.79%

Credit	Inital Debt	Re-Finance
Minimum DSCR	1.40	0.00
LLCR	1.40	
PLCR	3.02	



Model Mode (•) Structuring ( ) Risk Analysis [Fix Debt]

Returns	Nominal	Real	MIRR
Pre-tax Project IRR	6.14%	2.89%	6.90%
Post-tax Project IRR	5.36%	2.12%	6.82%
Debt IRR before Tax	4.44%	1.03%	6.89%
Debt IRR after Tax	3.64%	0.25%	6.85%
Equity IRR	7.49%	4.10%	7.04%
Credit	Inital Debt	Re-Finance	
Minimum DSCR	1.40	1.15	
LLCR	1.40		
PLCR	3.09		



Mechanics of Re-financing

To enable flexible re-financing in a model, the most essential things to do are to include: (1) time switches for the re-financing period and the re-financed debt repayment period; (2) a separate sources and uses analysis for the re-financing; (3) a new debt schedule for the re-financed debt; (4) a user defined function to compute the size of the debt given the new DSCR; and (4) provisions in the existing debt schedule to repay the debt early. Once you are comfortable with creating switches from the period codes; creating a sources and uses analysis and structuring debt schedules, programming the re-financing is nothing new. Inputs for re-financing demonstrated below:

Re-Financing Assumptions			
Re-Financing Switch	Switch	FALSE	
Year of Re-Financing	Year	4	
Date of Re-financing	Date	01-août-18	
Re-financing Target DSCR	Times	1.16	
Re-financing Debt Term	Year	15	
Start of Re-financing	Date	01-févr-19	
Finish of Re-financing	Date	01-févr-34	
Re-financing Amount		1,121.78	<---- =sculpt_debt_refinance(W(
Re-financing Test		TRUE	
Starting NOL in Re-finance Period	EUR 000	0.00	
Credit Spread on Re-financing	Percent	2.00%	
Fees on Re-financing	Percent	1.50%	

The excerpt below illustrates how re-financing can be incorporated in a model using a simple example. In this example, all of the debt is paid with a cash sweep and re-financing occurs every three years. The tricks in making the model involve creating a line on a new sources and uses statement that computes the remaining balance of the original debt or the re-financed debt and using the re-financing switch. This calculation is the opening balance less any repayments from the cash flow sweep for the current year (the closing balance cannot be used because it already includes the re-financing. The cash flow statement should include a line for new debt financing, repayment of existing debt and the interest expense must include the interest on the current debt as well as the re-financed debt.

	D	E	G	H	I	J	K	L	M
19	Period Code		0	1	2	3	4	5	6
20	Remaining life		20	19	18	17	16	15	14
21									
22	Adjusted Re-financing Switch	=MOD(G19,$E$15)=0---->	TRUE	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE
23									
24	CADS			120.00	123.60	127.31	131.13	135.06	139.11
25									
33	Sources and Uses for Re-financing								
34	Sources - New Debt	=$E$13*H22---->		0.00	0.00	800.00	0.00	0.00	800.00
35	Uses - Repay Exiting Debt	=(H41-H42)*H22---->		0.00	0.00	305.19	0.00	0.00	0.00
36	Uses - Repay Re-finance Debt	=(H48-H50)*H22---->		0.00	0.00	0.00	0.00	0.00	478.49
37	Uses - Dividends	=H34-H35---->		0.00	0.00	494.81	0.00	0.00	800.00
38									
39	Debt Schedule								
40	**Initial Debt**								
41	Opening			600.00	510.00	411.90	0.00	0.00	0.00
42	Less: Repayments (Sweep from Cash Flow)			90.00	98.10	106.71	0.00	0.00	0.00
43	Less: Payments at Re-financing	=MIN(H35,H41)---->		0.00	0.00	305.19	0.00	0.00	0.00
44	Closing Balance		600	510.00	411.90	0.00	0.00	0.00	0.00
45	Interest Rate			5%	5%	5%	5%	5%	5%
46	Interest Expense			30.00	25.50	20.60	0.00	0.00	0.00
47	**Re-financed Debt**								
48	Opening Balance			-	-	-	800.00	700.87	593.85
49	Add: Draws			0.00	0.00	800.00	0.00	0.00	800.00
50	Less: Repayments (Sweep from Cash Flow)			0.00	0.00	0.00	99.13	107.03	115.36
51	Less: Repayment at Re-financing	=MIN(H35,H48)---->		0.00	0.00	0.00	0.00	0.00	0.00
52	Closing Balance			0.00	0.00	800.00	700.87	593.85	1,278.49

Chapter 44: Incorporating Covenants and Cash Flow Sweeps in Project Finance Models

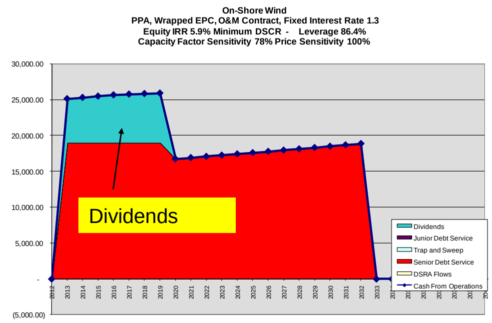
In negotiating with loan agreements, one of the subjects that must often be analysed in a financial model is the level of covenants and cash flow sweeps which can be referred to as credit enhancements. Covenants can range from mandating that equipment is in good working order to strict limitations on payment of dividends. For modelling purposes, it is the latter type of negative financial covenants that are generally tested. These covenants can influence returns to equity investors because they affect the timing of cash flows that are paid out as dividends. The covenants can take the form of cash flow traps that limit dividends when times are bad (and there is not much cash flow available for dividends anyway). These covenants would typically state that the last period, current and prospective DSCR must be above some minimum level. Alternatively, the credit enhancement can be in the form of cash flow sweeps which limit the cash flow that can be distributed when times are good. A cash flow sweep may be linked to the debt to EBITDA ratio and mandate for example that if the debt to EBITDA is above 5.0, 70% of the cash flow must be used to pay down debt rather than being allowed as a dividend.

Covenants and cash sweeps do not change the operating cash flow and cannot make a good project into a bad project. Instead, they can only change the timing of who receives the money and in what order. With more restrictive covenants, the equity holders must wait to get their dividends; while without the covenants, the equity holders can receive cash flows earlier. Credit enhancements involve a trade-off between risk for lenders and return for shareholder which can be assessed with a financial model. The efficacy of the covenant depends on the structure of the cash flow. If cash flow is increasing over time, the covenant will not be effective in reducing risk because there are no dividends to trap. On the other hand, if the cash flow “falls off a cliff” after a few years, the sweep and covenants can be effective. The graph below shows a case where cash flow fell down and a covenant limits dividends (the right panel) compared to a case where dividends are allowed, which may cause a default later on in the life of the loan.

Effect of Cash Sweep With Declining Cash Flows

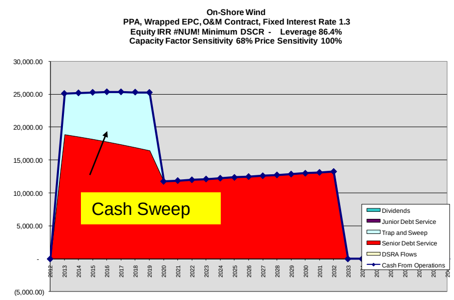
- No Enhancements

Without enhancements, the break-even is 78%



- With Cash Flow Sweep

With a sweep, the break-even is 68%



With declining cash flows, the break-even point reduces significantly

The mechanics of modelling covenants involves cash flow waterfall techniques where line item in the debt schedule are tied to the cash flow statement and MIN and MAX functions are used in the cash flow statement. In the case of covenants, the cash that is not allowed to be paid in dividends can be either used to pay off debt earlier than scheduled or alternatively, it can be placed in a cash reserve account. The use of trapped cash depends on language in the loan agreements. If cash is used to pre-pay debt, the cash that is trapped should be included in a line item in the debt schedule. If the cash is applied to a reserve account, a separate account should be set-up the below the debt module.

The step by step process below describes how to incorporate a cash trap or a cash sweep covenant into the cash flow portion of a model.

Step 1: In the cash flow statement below the scheduled debt service, add sub-total rows that show the cash flow that is available for a cash sweep or a cash covenant.

Step 2: For a covenant, include a switch variable that yields a TRUE or FALSE depending on whether the covenant has or has not been violated (you could put this below the cash flow statement). This test may be against the debt service coverage ratio or against the debt to EBITDA ratio (in a leveraged buyout).

Step 3: Multiply the dividend covenant switch variable by the cash flow sub-total to compute the amount of cash trapped.

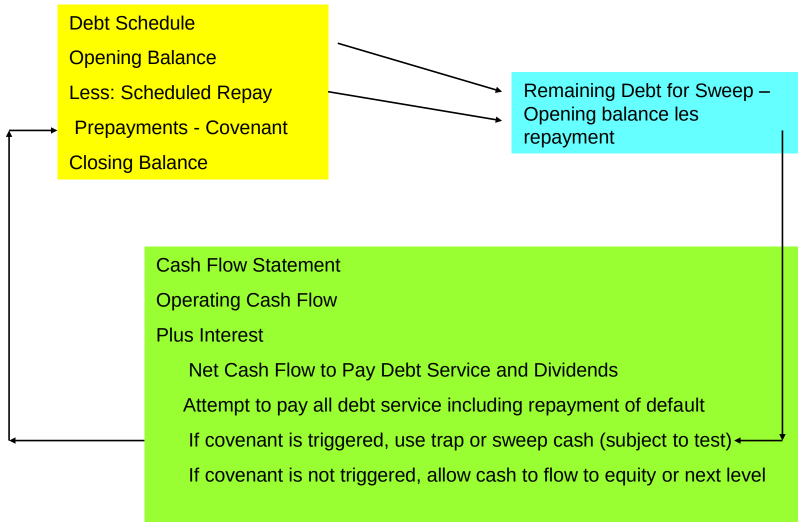
Step 4: In the case of a cash flow sweep, include a line item that lists the cash flow sweep percentage as a function of the debt to EBITDA ratio or some other criteria above or below the cash flow statement.

Step 5: Multiply the cash sweep percentage by a sub-total in the cash flow waterfall that computes the cash flow available for a sweep.

Step 6: The cash flow that is trapped or swept and cannot pay dividends must go somewhere. One typical option that applies to the cash sweep is to use the cash to pre-pay debt. A second that is typical for a cash trap covenant is to build-up cash in a reserve fund. If

cash is used to pay down debt, then as long as the minimum function is used in the repayment analysis, then the debt will appropriately be paid earlier. If the reserve account is used, then an item must be added that releases cash from the reserve when the covenant is met or the debt is repaid.

The diagram below illustrates how process for covenants or cash flow sweeps links the cash flow statement to the debt schedule. The intermediate box in the diagram demonstrates that evaluation must be included in the cash flow statement to assure that the cash flow sweeps are not pre-paying more debt than is outstanding. If all of the debt is paid, there is no longer a reason to sweep any cash.



Chapter 45: Unique Challenging Issues in Real Estate Modelling Involving Portfolio of Assets, Progress Payments and Lease Rolls

Real estate analysis and modelling encompasses a mixture of aspects from both corporate finance and project finance. A hotel project or a commercial building has similar characteristics in terms of analysis to project finance modelling. Like typical project finance, these projects move through different stages; revenue and contracts are important in risk analysis; and the financial analysis is driven by cash flows and IRR's rather than profits. On the other hand, hotels and commercial buildings do not have a defined life; they rely on rental market history and are often valued at a flexible terminal date which makes them similar to corporate analysis. Analysis of other real estate projects such as residential and commercial mixed development projects have more things in common with corporate analysis. These investments are portfolios of projects with different cash flow patterns and risks. Financing is driven by loan to value rather than coverage ratios and the residual values at some terminal date is a key part of the valuation. But the individual components of the mixed development projects are evaluated much like project finance.

The structure of real estate projects affects the type of ratios used to evaluate the credit quality and the equity value of the projects. Because of the indefinite life and the ability to sell projects, the loan to value ratio is often used in lieu of the DSCR in project finance. Unlike corporate analysis where the net present value of free cash flow and return on invested capital is used to evaluate investments, real estate projects rely on the IRR realized by different investors as in project or structured finance. Other types of investments have similar characteristics to real estate projects where aspects of project finance and corporate finance analysis are applicable. One example is analysis of solar roof-top projects where multiple individual solar projects can be added to a portfolio as with a residential development.

Despite similarities with corporate and project finance models, there are some unique and difficult issues associated with real estate models:

- Structuring portfolios of real estate projects in which each project has different start dates; holding periods and construction profiles;

- Incorporating dates that do not begin at the start of a month or quarter in a quarterly or monthly model;

- Computing the payments received from residential properties when the payments are derived from progress payments along with assumptions with respect to how the residential properties are marketed.

- Calculating the distribution of capital expenditures (S-curves) that are flexible enough to reflect different construction periods as well as the manner in which expenditures are spent over time.

- Reflecting a portfolio of leases with different lease terms, potential idle time periods and renewal probabilities.

- Programming unique aspects of financing a portfolio of different projects where some projects are producing cash flow while other projects require financing of capital expenditures.

In explaining how do deal with these somewhat painful issues, this chapter assumes that you have reviewed the sections that address project finance models related to setting-up project phases and time periods and describes some features of a real estate model that are different from a project finance model. Differences in the structure of real estate models include:

- In modelling a single project such as a multi-family development or a hotel, the sale of a project after a given holding period is often assumed.

- In modelling developments that include a portfolio of different projects, cash flow is generated before construction of all of the projects is completed. This means that a separate sources and uses analysis is not a good way to structure models as it is with for project finance analysis.

- In modelling real estate projects, there are often multiple different units and buildings which are completed at different dates. To consolidate projects with different start and end dates, separate project by project timeline switches can be established using a common master time line for all projects. The switch variables are then all adjusted to the common master time line.

- In modelling commercial real estate investments, the analysis should include the effects of different lease terms with alternative expiry dates. Modelling idle time and lease renewals can result in long and non-transparent formulas.

- Some real estate projects have multiple participating tranches with different return targets and sharing mechanisms.

Modelling a Single Real Estate Project

An effective way to understand a real estate project is first to model a single project and then later to put projects together in a portfolio. Modelling a single project is very similar to modelling project finance with the exception that a holding period is defined after which the project is sold. Operating inputs that drive the value of the project include the occupancy rate that varies with the life of the project, the rental rates which can be volatile, occupancy rates that are correlated with the rental rates and fixed and variable operating expenses. Rather than using the total project life to measure the operating period as in a typical project finance model, the operating period is generally defined by the holding period before which the project is sold. Then, similar to acquisition models, the project is sold after the holding period. This

can be accomplished through dividing the cash flow by the cap rate which is a percentage and also by a terminal value switch.

A cap rate measures the value of a project relative to pre-tax cash flow and is about the same as the inverse of the EV/EBITDA ratio. In modelling the cap rate you can make a terminal value switch which is simply a TRUE/FALSE logical variable that is defined with the formula = (period = holding period). The theory behind the cap rate is very similar to the ideas underlying computing the terminal value using the final year cash flow divided by the cost of capital minus the growth rate. If you believe the growth rate in rents is 2.5% in a market and the cap rate is 5%, then the implied cost of capital is 7.5% as shown below. With a higher growth rate the cap rate should be lower and if the cash flows are less risky (for example, if there are fixed leases) then the cap rate is also lower.

Cap Rate = WACC – g or WACC = Cap Rate + g

Once the proceeds from selling an asset are computed (net of fees and other transaction costs) a couple of accounting and tax issues arise. For tax purposes a capital gain is generally computed as the sales proceeds less the net book value of the fixed assets. The capital gain is the sales proceeds less the book value of the project. Real estate debt can take many forms as with project finance debt, but when the project is sold at the end of the holding period, the debt must be repaid.

Modelling a portfolio of different projects and the Painful Problem of Beginning a Model with Dates that do not start at the Beginning of a Quarter or a Month or a Year

One of the complex and challenging aspects of real estate modelling involves modelling multiple projects that are part of a combined portfolio. When creating such a project you would like to be able to change the occupancy dates, the construction periods, the S-curves, timing or proceeds selling from residential projects and other items of different parts of a portfolio. An efficient way to program different projects in a portfolio that reflects different time periods you can create a user-defined function that computes the percent of a period a project is being constructed and being operated. Alternatively you use a combination of the INDEX function and the DATA TABLE that is analogous to creating scenarios. The next few paragraphs explain how you can use either method.

No matter what method you are using to consolidate a portfolio of projects, the first essential step is to establish a start date that will be common to all of the projects. If each column of the spreadsheet has the same date, then one can eventually add up all of the separate projects to obtain the aggregate cash flow for the calendar period. This contrasts with many project finance models where the start date of the model and the start date of the construction or development are the same.

To create a portfolio of projects you can model the individual projects. The key to using this method is to apply a function that measures what percent of the period a project is in service or under construction. You can use these percentages for a series of other calculations. Use of the percent of time function is illustrated in the excerpt below:

	A B C D	E	F	G	H	I	BM	BN	BO	BP	BQ	BR	BS
1	**Timeline**												
2	Start Date					01-janv-13	01-sept-17	01-oct-17	01-nov-17	01-déc-17	01-janv-18	01-févr-18	01-mars-18
3	End Date				31-déc-12	31-janv-13	30-sept-17	31-oct-17	30-nov-17	31-déc-17	31-janv-18	28-févr-18	31-mars-18
4	Year				2012	2013	2017	2017	2017	2017	2018	2018	2018
5	End of Quarter				31-déc-12	31-mars-13	30-sept-17	31-déc-17	31-déc-17	31-déc-17	31-mars-18	31-mars-18	31-mars-18
24			1	2	3	4							
25	**Operating Assumptions**		Timing Assumptions			Ge							
26		Project IRR	Code Number	Construction Start	Construction Months	TOP Date							
27	Land		1	01-janv-13	11	01-déc-13							
28	Infrastructure		2	01-oct-13	11	01-sept-14							
29	Residential 1	25.46%	3	01-oct-16	19	01-mai-18							
30	Residential 2	18.74%	4	01-janv-18	19	01-août-19							
31	Residential 3	24.48%	5	01-janv-15	19	01-août-16							
32	Retail	29.68%	6	13-juin-16	19	13-janv-18							
33	Office	25.37%	7	30-mars-16	19	30-oct-17							
34	Shopping Centre	20.21%	8	14-juil-16	19	14-févr-18							
35								=percent_of_time($E206,$G206,BN$2,BN$3)					
203	**COMMERCIAL REVENUES**												
204	% of period in operation - Commercial Holding Peri	TOP date	Holding perio	Terminal date									
205	Retail	13-janv-18	3.00	13-janv-23	60.00	0.00%	0.00%	0.00%	0.00%	0.00%	61.29%	100.00%	100.00%
206	Office	30-oct-17	3.00	30-oct-22	60.00	0.00%	0.00%	6.45%	100.00%	100.00%	100.00%	100.00%	100.00%
207	Shopping Centre	14-févr-18	3.00	14-févr-23	60.00	0.00%	=percent_of_time($E207;$G207;BM$2;BM$3)				0.00%	53.57%	100.00%

Effectively applying creating a portfolio can be accomplished with a few user-defined functions. These functions include:

1. A function that computes the percent of a period a project is in operation or under construction through comparing begin and end dates of a project with start and end dates of the timeline. The important and tricky aspect of this function is to compute the portion of the period for the first and the last periods.

2. A function that computes the temporary occupancy date (TOP) of a project given the S-curve so that one can enter different S-curves and derive different TOP dates.

3. A function that computes the revenue received in a residential project given both the progress payment schedule and the sales or marketing schedule. Some projects may receive the whole series of progress payments and other residential projects that are sold later receive the revenues later and must accumulate the payments that were scheduled.

The percent of time function is computed by comparing the individual project start and end dates with the project time line. To make the function, compute a ratio of days with a series of IF statements:

```
Function percent_of_time(start_operation, end_operation, start_of_period, end_of_period)

If start_operation > start_of_period Then ratio = 0          ' Before the operation start the ratio is zero

' Start date is between the beginning date and end of period

If start_operation >= start_of_period And start_operation < end_of_period Then _
   ratio = (end_of_period - start_operation + 1) / (end_of_period - start_of_period + 1)   ' Ratio is period days/total days

If start_operation <= start_of_period And end_operation > end_of_period Then ratio = 1      ' full period; ratio is 1.0

 ' End of period -- test on end_operation

If end_operation >= start_of_period And end_operation <= end_of_period Then _
     ratio = (end_operation - start_of_period + 0) / (end_of_period - start_of_period + 1)   ' ratio is days in period divided by total

If end_operation < start_of_period Then ratio = 0                                          ' After end of life; ratio is zero

percent_of_time = ratio

End Function
```

To use the INDEX and DATA TABLE method you can develop a template model that can be used to compute the operating cash flow for each project. To make a template that works for each individual project, you can use the INDEX function along with a code number for each individual part of the portfolio. In the simple example presented below, the index command would be used to define the cost, the sale price, the construction profile and the period finished for the three components of the project. A single cash flow model would be set-up that uses the different cost, sales price and other inputs. If the inputs are set-up in a structured manner with items such as the completion date, the cost, the lease rate, the capitalization rate, the utilization rate and other factors, the amounts can be extracted for each separate project. In addition to the input data for individual projects, general assumptions should be made for factors such as the general inflation rate.

	Code Number	TOP Date	Construction Cost	Gross Area Sq Foot	Units	S-Curve Code	Net Floor Area	Rental Rate	Service Charge	Occupancy Code Number	Holding Period	Cap Rate
Land	1	01-juil-10	50,000	1	1	1.00						5%
Infrastructure	2	01-oct-10	1,000	1	1	2.00						5%
Residential 1	3	01-juil-13	50	1,000	100	3.00	800.00					5%
Residential 2	4	01-janv-15	70	1,000	80	3.00	800.00					5%
Residential 3	5	01-janv-16	55	1,000	120	4.00	800.00					5%
Commercial 1	6	01-avr-15	85	150,000	1	4.00	90,000.00	6.00	2.00	1.00	5.00	5%
Commercial 2	7	01-janv-16	95	100,000	1	4.00	60,000.00	6.00	2.00	2.00	5.00	5%
Commercial 3	8	01-oct-17	90	80,000	1	4.00	48,000.00	6.00	2.00	3.00	5.00	5%

After the common start date is established you can compute a period code in the template model. This is done through comparing the commercial operation date (sometimes called the temporary occupancy date in real estate) and the common start date. Using the inputs in the above example, the period code would be different for the first and the second project – it would be a larger negative number for the project with the further out date. This is analogous to computing the construction periods discussed above for the project finance model. Recall that if a periodic model is used, the DAYS360 function can be applied. (If the days in a 360 day are known and the model is computed on a monthly basis, then the DAYS360 command should be divided by 30.)

To see how this process works with the INDEX and DATA TABLE method, assume that the common start date is 2012 and that there are two operating components. The first has a start date in 2014 and a two year construction period and the second has a start date of 2015. Both have a cost of 1,000 and a two year construction period. In this case the first period for the initial project is -1 and the first period for the second project is -2. The construction period is -1 and 0 for both projects. Since -1 is in the first year for the first project and it is the second year for the second project, the construction expenditures are arrayed differently. The manner in which the model for individual components can be set up is illustrated below. In the table below, the period code is used to define the S-curve table that defines construction expenditures as a function of the period code. The S-curve can is established by using an HLOOKUP table.

Individual Project Model										
Code Number	8									
Name	Commercial 3		=INDEX($D$65:$D$72,E76)							
S-Curve Code	4.00		=INDEX(J65:J72,E76)							
TOP Date	01-oct-17		=INDEX(F65:F72,E76)							
Periods before TOP Date	30.00		=DAYS360(E3,E81)/E10							
Sales Price - per Sq Foot	0		=INDEX(S65:S72,E76)							
Progress Payment Code	1		=INDEX(T65:T72,E76)							
Total Sales Value	-		=E99*E88*E89							
Project Timeline -- Common Timeline										
Start Date	01-avr-10	01-juil-10	01-oct-10	01-janv-11	01-avr-11	01-oct-12	01-janv-13	01-avr-13	01-juil-13	01-oct-13
End Date	30-juin-10	30-sept-10	31-déc-10	31-mars-11	30-juin-11	31-déc-12	31-mars-13	30-juin-13	30-sept-13	31-déc-13
Year	2010	2010	2010	2011	2011	2012	2013	2013	2013	2013
Quarter	0	0	0	0	0	0	0	0	0	0
Age in Years	0	0	0	0	0	0	0	0	0	0
Period	-29.00	-28.00	-27.00	-26.00	-25.00	-19.00	-18.00	-17.00	-16.00	-15.00
Construction Switch	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE
Holding Switch	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
Terminal Switch	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Once the individual cash flow model is established, the amounts from the individual parts should be aggregated in creating a financial model. The aggregation can be accomplished by using the data TABLE function. The code for the individual project is the column sensitivity in the data table and the column input is the number used in defining the INDEX function. In the above example, the column input is the cell reference for the number 1. Simply add the cash flows for different projects using a date code that begins with the overall model start date that was used to compute the period code for each project. The manner in which the data table can be used to aggregate cash flows from individual projects is illustrated in the table below.

Cash Flow Analysis											
Total Proceeds from Sales											
Residential Type 1	-	-	-	-	-	1,500.00	-	-	-	-	-
1 Residential Type 1	-	-	-	-	-	1,500.00	-	-	-	-	-
2 Residential Type 2	-	-	-	-	-	-	-	2,500.00	-	-	-
3 Commecial	-	-	-	-	-	-	-	-	-	-	3,200.00
Construction Expenditures											
Residential Type 1	-	-	250.00	500.00	250.00	-	-	-	-	-	-
1 Residential Type 1	-	-	250.00	500.00	250.00	-	-	-	-	-	-
2 Residential Type 2	-	-	-	-	500.00	1,000.00	500.00	-	-	-	-
3 Commecial	-	-	-	-	-	-	-	750.00	1,500.00	750.00	-
Net Cash Flow											
1 Residential Type 1		-	(250.00)	(500.00)	(250.00)	1,500.00	-	-	-	-	-
2 Residential Type 2		-	-	-	(500.00)	(1,000.00)	(500.00)	2,500.00	-	-	-
3 Commecial		-	-	-	-	-	-	(750.00)	(1,500.00)	(750.00)	3,200.00

Once the cash flows are aggregated, the financial model can be developed. Since there are multiple parts with different construction and cash flows, the model should not necessarily begin with a sources and uses statement. Instead, a working capital facility and a debt facility can be developed for situations when the cash flow is negative. Similarly, a routine can be developed to issue equity before or after the issuance of debt. Methods to develop the debt schedule and a cash flow statement with a waterfall involving structuring the cash flow statement and using the MIN and MAX functions is described above.

The general idea of establishing the size of debt and the debt capacity is an important issue in risk analysis and cost of capital. In determining the amount of debt that can be supported by a company or a project, one cannot generally boil the analysis down to a simple formula such as setting the debt service coverage ratio to 1.6 in order to obtain a BBB bond rating. Once the process of setting some financial ratio to a benchmark level has been established, the mechanical process depends on how the level of debt is computed in a model. A simple approach is to compute the debt level from a given leverage ratio through multiplying the total uses of funds by the ratio. This method can lead to circularity problems because the amount of the fees and the interest during construction drive the uses of funds. This method does not conform to reality and it does not allow computation of items such as commitment fees, up-front fees and required funding of cost over-runs.

In some real estate projects, projects are held for trading rather than investments. In these cases, cash flow is generated from receiving progress payments before construction is complete. This cash generated from selling a project reduces the need for additional debt. Further if the proceeds are more than the total amount of debt required, the cash is deposited into a reserve account. If there is money in this cash reserve account and future financing needs occur, then the reserve account is used for future cash needs. This cash process can be modelled in a similar way as the cash process that was described in a standard corporate model where deficit cash flow is funded by raising new debt and surplus cash goes to retiring cash and/or reducing debt.